VOL. VIII, No. 4 OCTOBER, 1926 Old Series: Vol. xxiv No. 4

The Journal of Bone and Joint Surgery

THE MECHANISM AND TREATMENT OF BACKFIRE FRACTURE

BY HAROLD C. EDWARDS, M.B., B.S., F.R.C.S., LONDON

Surgical Registrar, King's College Hospital

Backfire, or Chauffeur's Fracture, is an injury which, although extremely common in these days of voluminous traffic, seems to have escaped the attention which its frequent occurrence demands. The pioneers of fracture work had no opportunity of seeing and investigating this modern type of injury. Present day manuals of Surgery dismiss the subject with a few lines at the end of a chapter on fractures of the forearm.

But there is another conspicuous fact about backfire fractures, and that is the diversity of opinion which exists as to the exact nature of the injury. Here are two quotations taken from two modern and widely read manuals of Surgery:—

(a) " . . . A Chauffeur's fracture of this bone has also been described. It involves the lower end of the radius about two to three inches above the wrist . . . well marked anterior displacement is usually present."

(b) " . . . The Chauffeur's fracture is an oblique fracture of the lower end of the radius by which a triangular portion of bone, including the styloid process, is separated from the main bone."

The following account is based on forty-two cases of backfire fracture which have been treated at the fracture clinic at King's College Hospital, since its institution in 1920. The cases do not in any way comprise the whole number treated, a large number having been omitted for various reasons. Only cases in which the chain of evidence of history and x-ray is complete have been considered.

In cranking a car, backfire may occur either on the downward swing or on the upward pull. In the latter case, the likelihood of fracture is less than the former. The handle will tear itself from the grasp, and may at the most only wrench the tendons of the forearm, though there is just a possibility that the handle will, having performed a complete revolution, crash on to the back of the forearm and cause a bony injury.

The probability is that the great majority of backfires which cause fracture occur on the downward swing, and for this reason chauffeurs are

in the habit of starting the engine on the upward pull alone. Some engines are difficult to start, however, and will only spark on swinging.

It is well known among car drivers how liable an engine is to backfire if the spark is too advanced, or if the oil has become sticky on the piston so that sufficient velocity cannot be obtained to get a spark at top dead centre, and it is common knowledge how these difficulties can be overcome. Yet the accident occurs with increasing frequency — a fact due partly to the great increase in car owners, and partly to the carelessness of drivers who have for a long time been immune from this accident.

Many and varied are the types of fracture which may result from a backfire, though they are practically all somewhere below the junction of the lower and middle thirds of the radius. At first, looking through the x-rays of a large number of cases, it would appear that there is no uniformity, and that "anything may happen". And yet, as experience of these fractures increases, there emerge from the mass "types" which one meets with regularly, and immediately one gets the impression that the mechanism of fracture is constant for each. For instance, take the two fractures quoted from the manuals of Surgery. Both not only occur in backfire, but occur with great frequency, and are always true to type. It would be unreasonable to suppose that they both occur from identical types of violence.

We are dealing not with rods of uniform strength and thickness, but with a complicated system of bones, ligaments and joints, and the elementary principles of stress and strain are difficult to apply, and the mechanics of backfire fracture become more a matter for speculation than for dogmatism. At the outset it would seem easy to divide all the fractures into two groups:

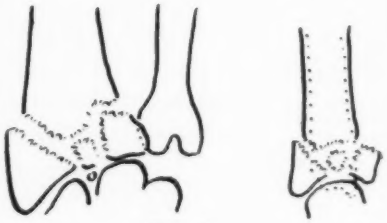


FIG. 1

(1) Direct, in which the starting handle flies out of the hand and strikes the forearm.

(2) Indirect, in which the fracture occurs without the handle leaving the hand. But even this simple division is difficult, for it is often impossible to obtain a reliable history. Backfire is so sudden and unexpected that a sufferer can sometimes remember little between the attempt to start the car and the time when he is nursing an injured forearm. He is not to be blamed for being unable to tell whether the handle struck him or not. It becomes then a question of framing theories in the hope that facts bear them out rather than the reverse, which is so obviously the better way, and it is in the full appreciation

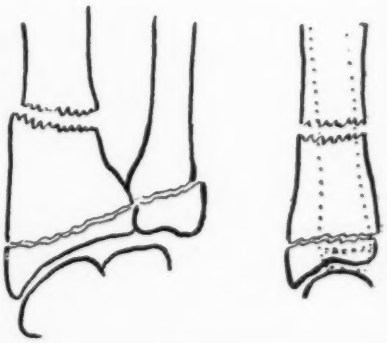


FIG. 2
Epiphyses not yet united.

of the many pitfalls that may arise in arriving at conclusions of purely theoretical merit that the following explanations are offered.

The fracture can occur in two ways:

I. *Fractures Due to Direct Violence.* In this case the handle is wrenched from the hand, and, swinging back, performs one complete revolution and crashes on to the front of the lower part of the forearm or hand.

The fracture occurs at the point of impact of the crank handle, the actual site varying with the downward excursion of the hand beyond the level at which the backfire occurred. Fracture may thus occur at any point on the limb below the middle of the forearm. Occasionally the scaphoid or trapezium is fractured. In fractures of the radius, the displacement tends to be backwards, this being the direction of the violence. Perhaps the most common injury produced by direct violence is that in which the radius fractures about one inch from the articular surface. A curious feature about this fracture is that there is normally little or no displacement of the lower fragment, and the fracture appears to be just a transverse crack in the bone.

ILLUSTRATIVE CASES

(1) H. — . On Monday, January 23, 1922, 15 H. P. Daimler Car. Crank gripped with thumb in line with fingers (see Fig. 4). On the downstroke the handle flew out of his hand and struck him. There was a comminuted fracture of the lower end of the radius (Fig. 1).

(2) S. — . June 1923. Princess 10 H. P. Car. Thumb behind. Handle wrenched out of hand and struck him (Fig. 2).

II. *Fractures Due to Indirect Violence.* In these cases, fracture occurs before the handle leaves the hand. As the crank handle kicks back it jolts the hand on the forearm, and fracture occurs at some distance from the point of application of the violence. The position of the fracture would seem to depend upon the way in which the handle is grasped.

(a) *With the thumb in front.* The strongest grip which the hand can exercise is that in which the fingers curl around the handle with the thumb

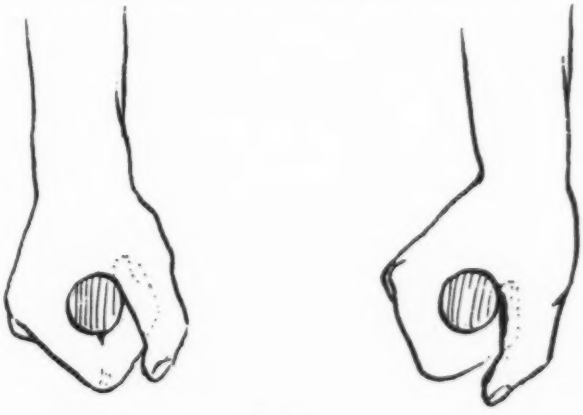


FIG. 3

Thumb in front. Shaded circle shows crank handle. (a) without dorsiflexion. (b) with dorsiflexion.

FIG. 4

Thumb behind. (Position II.)

passing around on the other side and coming to rest on the back of the fingers. In this way the fist is tightly clenched around the crank, with the latter lying obliquely across the palm, and its proximal end wedged between the first two metacarpal bones. When the downward push is given in starting the engine, the carpus may be either in the same plane as the forearm or dorsiflexed (Fig. 3).

(b) It is common knowledge among chauffeurs that, should backfire occur when position (a) is used, the handle will not be able to disengage itself from the encircling hand, and the arm will bear the whole brunt of the impact. For this reason, most chauffeurs hold the crank with the thumb behind and in line with the fingers (see diagram) (Fig. 4).

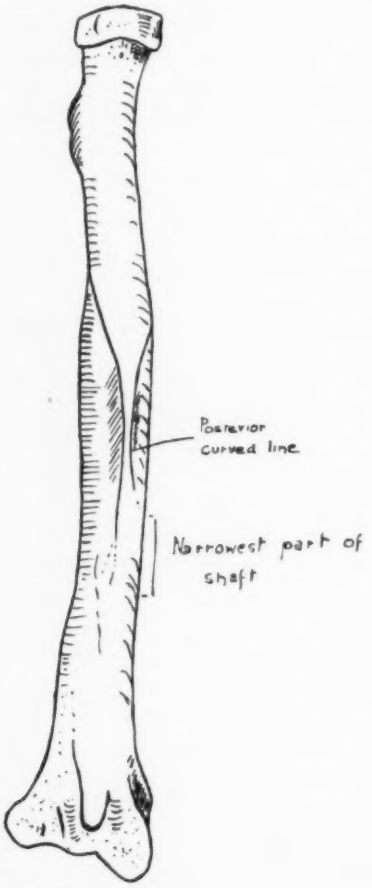


FIG. 5

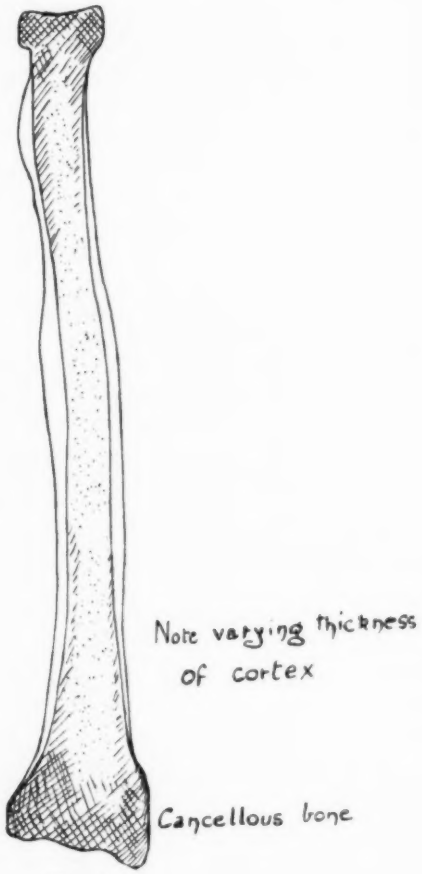


FIG. 6

In this position the backfire crank will more readily disengage itself from the hand, and the risk of fracture is presumably lessened. This grip does not seem to diminish the risk, however, as a large number of fractures in this series have been sustained with the hand in this position. In order

to get a good push down on the handle with the thumb in line with the fingers, the hand is fully dorsiflexed on the forearm, as shown in the diagram.

Let us turn for a moment to a general survey of the anatomy of the lower end of the radius.

The styloid process of the radius projects sharply downwards with an inclination outwards, and bears on its inner surface part of the radial articular surface of the radio-navicular joint. The styloid process thus partly covers the navicular bone on its outer side. Immediately above the distal end of the radius the anterior surface is flattened to form a quadrate area. The sides converge above to the narrowest part of the radial shaft, two and a half to three and a half inches from the distal extremity. The outer border line is stout and rod-like, but the inner border well defined and thin (Fig. 5).

At this level of minimum width also lies the level of minimum depth. Anteriorly, the surface of the lower two-thirds of the radius is smooth and uniformly flat, but posteriorly it is raised above with a fairly stout buttress of bone, which, commencing at the level of insertion of the supinator radii brevis muscle, passes downwards as the posterior curved line. At the junction of the middle and distal thirds of the bone this ridge becomes less defined and this part of the posterior radial surface is uniformly convex. The ridge again becomes prominent lower down, and terminates in the posterior radial tubercle, to the ulna side of which the extensor pollicis longus glides. This uniformly convex area corresponds to the area of minimum width, and because of the subsidence of the posterior curved line, this is also the area of minimum thickness. It is an isthmus uniting two stouter masses of bone, and would seem to be the weakest point of the lower radial shaft.

But this, though it is a tempting conclusion to draw, cannot be the whole truth. If it were, why should a Colles' fracture be the commonest fracture of the forearm in adults? It is well known that strength of bone is dependent not so much upon girth as upon the relative proportion of compact and cancellous tissues. Examination of sections of a normal radius cut in its long axis, first in a lateral and then in an anteroposterior plane, shows that the cortex of the bone is thickest at the middle of the shaft, and has diminished to a mere shell immediately before the compact bone of the wide distal end is reached, which suggests that the "Colles" area is the most liable point for the bone to fracture (Fig. 6).

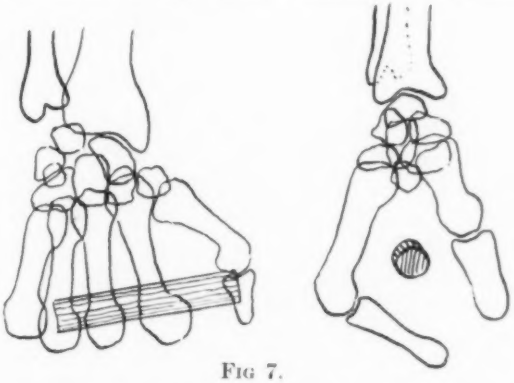


FIG 7.

Tracing of X-ray of carpus holding glass handle. Note abduction of carpus (phalanges omitted).

But the site of fracture in indirect violence does not depend solely upon the strength of the bone, otherwise all violence transmitted through

FIG. 8

the carpus would probably result in a Colles' fracture. The site depends also upon the direction of transmitted force, and the point upon the radius where this transmitted force is at its maximum. If the violence is applied with the carpus in abduction, the styloid process and the internal lateral ligament of the wrist joint bears the brunt, and fracture through the former, with or without the ulna styloid, will result. If the wrist is adducted, the main brunt will be borne by the external lateral ligament of the joint, and again the radial styloid process may be fractured. Both these occur in backfire fracture. If the abduction be accompanied by any dorsiflexion, a rotary movement occurs. The styloid process is prized outwards and backwards, and a Colles' fracture results—exactly what happens in falling upon the outstretched hand. Sometimes the styloid is fractured together with a fragment from the inner and posterior margin of the radial articular surface. If the wrist is hyperextended (dorsiflexed) without any suggestion of lateral deviation, the shock of the impact is referred up the radial shaft, the fulcrum being the posterior edge of the articular surface of the radius, and fracture will occur at the point in the radial shaft where the bone is weakest, i.e., at the junction of the middle and lower third, three inches above the lower end.

FIG. 9

Crank handle gripped with carpus adducted.

Let us now apply these views to clinical facts, and see what happens for all positions of the hand upon the crank handle.

Position 1. The tracings of the x-ray of a hand passing around an imaginary glass crank handle in this position show that the axis of the carpus does not correspond with that of the radius. There is a slight degree of abduction at the wrist joint, as seen in the anteroposterior view. The wrist may or may not be dorsiflexed (Fig. 7).

What happens (a) *When there is abduction but no dorsiflexion?* The hand is given a violent jolt, which is transmitted through the carpus to the radius. But as the latter is slightly abducted, the brunt of the impact is borne by the styloid process, which is broken off. There is usually little or no displacement of the fragment. Occasionally the navicular bone fractures in addition to the styloid process.

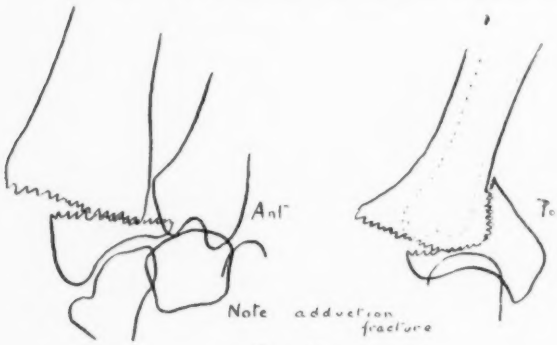


FIG. 10

ILLUSTRATIVE CASE

C.D. — 8.30 A.M. Starting 38 H.P. Daimler. Thumb right around handle. Handle not wrenched from grasp. Fracture through styloid process into joint (Fig. 8).

Occasionally this fracture through the styloid is clearly an adduction fracture, as shown in the case below. Here, no doubt, the hand holding the crank was bent to the ulna side, and was actually adducted when backfire occurred (Fig. 9).

ILLUSTRATIVE CASE

H.P.—10 A.M. Saturday, March 6. Thumb right around. Handle did not leave hand (Fig. 10).

(b) *When there is abduction and dorsiflexion of the wrist.* As the handle kicks back sharply it increases the dorsiflexion of the slightly abducted hand. This double direction, as it were, gives a sharp twist to the radius in a backward and outward direction, and the styloid takes the lower end of the radius with it, and a transverse fracture occurs, which somewhat resembles a Colles' fracture. The displacement may be slight. In the more severe cases the displacement is backwards, the lower fragment being rotated round the transverse axis, so that the articular surface faces downwards and backwards as in a Colles' fracture (Fig. 11).

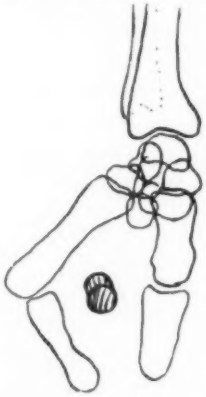


FIG. 11

Lateral view of hand on crank handle with dorsiflexion (only first two metacarpals shown).

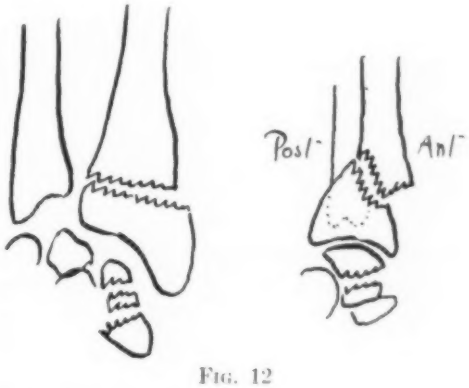


FIG. 12

ILLUSTRATIVE CASE

Wm. R. — 11 A.M. Wolseley Car. Thumb right around. Handle did not leave grasp (Fig. 12).

Position 2. When the thumb is placed behind the handle in line with the fingers there is no abduction of the carpus on the wrist. There is, however, dorsiflexion, which increases with the amount of force exerted on the crank handle in the downward push. When a backfire occurs, the jolt of the handle violently hyper-extends the wrist. The movement is a pure one—there is no abduction, and the styloid process of the radius is not involved. The radius will obviously fracture at the weakest point in the shaft, which is, as has been pointed out, between two and a half and three

and a half inches from the distal end. There is always marked angulation at the point of fracture, so that the distal fragment with the carpus is carried backwards, the proximal end of the lower fragment being often just anterior to the upper fragment. There may be in addition some lateral displacement. This is perhaps the most common type of fracture, and occurred in ten out of forty-two cases. In each case the thumb was placed behind the handle in line with the fingers, and according to the history the crank did not leave the hand until after the bone was broken (Fig. 13).

ILLUSTRATIVE CASE

C. B. — 16.9.23. 23 H.P. Ford. Thumb in line with fingers. Crank handle did not leave hand (Fig. 14).

Fracture before the Epiphysis has joined. The distal epiphysis of the radius joins the shaft in the twenty-first or twenty-second year. Many of the fractures occurred in men below this age, the youngest being a boy of fifteen. In these cases the most usual type of injury is a fracture just on the diaphyseal side of the epiphyseal line—the ordinary slipped epiphysis. Naturally one would regard the neighborhood of the epiphysis as the weakest point of the bone. It is surprising then to find that there are in this series, cases of boys under twenty-one in which the bone fractured high up, two or three inches above the lower end. In these cases the hand was in Position 2 when the car was cranked. One may gather that in all cases except some of those of pure hyperextension, the fracture is at the epiphysis.

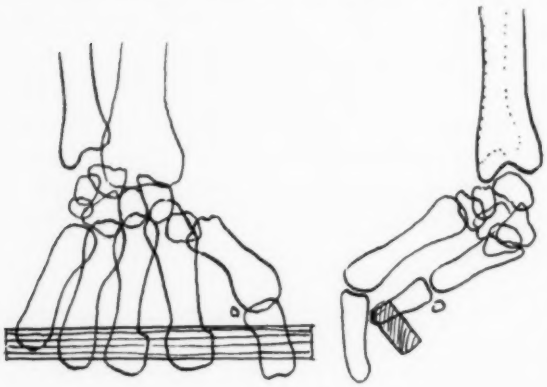


FIG. 13

Tracing of X-ray in Position II (with thumb behind). Note absence of abduction of carpus.

FIG. 14

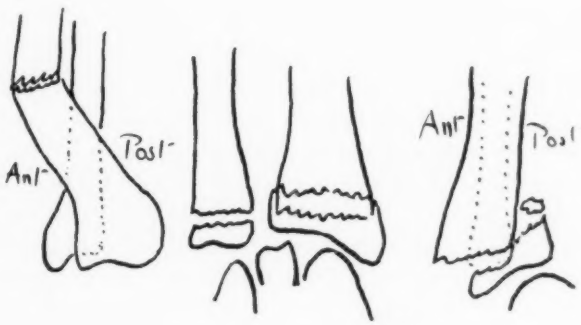


FIG. 15

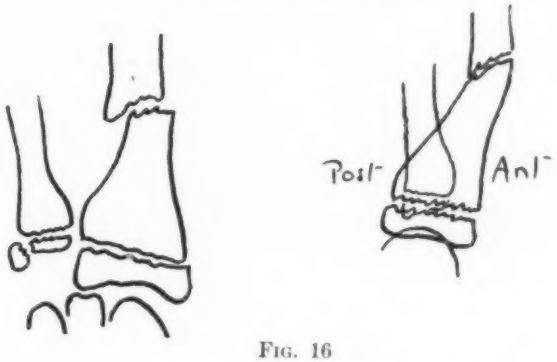


FIG. 16

ILLUSTRATIVE CASES

J. D.—age 15. 3-ton lorry. Thumb in line with fingers. Handle did not leave hand (Fig. 15).

20 H.P. Ford. Thumb behind in line with fingers. Handle did not leave hand (Fig. 16).

Unusual Injuries. There is one case in the series in which backward dislocation of the wrist occurred without bony injury.

SUMMARY OF FRACTURES

The following types occur as the result of backfire, each therefore with an equal right to be called a Chauffeur's fracture.

1. Fracture through the base of the styloid process of the radius, with or without the styloid of the ulna. This may be either an abduction or adduction fracture.
   Total cases 8.
2. Colles' fracture usually due to indirect violence, but may be due to direct.
   Total cases 7.
3. "High Colles'" due probably to direct violence, and situated one and a half to two and three-quarters inches above the lower end of the radius.
   Total cases 6.
4. "High" fracture through the radial shaft at the junction of the middle and lower thirds, almost certainly due, in all cases, to indirect violence. In one case the ulna styloid was fractured in addition.
   Total cases 10.
5. Fractures of the styloid process of the radius and inner and posterior margin of the radial articular surface.
   Total cases 2.
6. Separation of the radial epiphysis.
   Total cases 4.
7. Mixed types—Carpal and metacarpal bones.
   Total cases 5.

Total cases 42.

I regard the "High" fracture as the most constant in type of all backfire fractures. Except in one instance, I have never seen it occur apart from backfire. The case referred to was in a young adult of nineteen, who, while cycling, collided with the back of a stationary lorry. He fell forwards over the front of his bicycle and, in doing so, caught his hand between the handle bars and the brake bar immediately below. The probability is that as he fell forward he violently hyperextended his wrist.

TREATMENT

The first essential in the treatment of all cases is to reduce the fracture. Generally speaking, the more perfect the anatomical alignment obtained the more perfect the functional result will be. This generalization is nowhere, except perhaps in fractures near the ankle joint, more applicable. But certain displacements are far more important to correct than others, a point which will be entered into in discussing the treatment of each individual type.

I. *Colles' Fracture. Reduction.* Anteroposterior and lateral x-rays are taken so that the displacement may be accurately noted. An anæsthetic is given in all cases—nitrous oxide gas has preference—so that muscular relaxation is obtained, and manipulation is unhampered by the fear of hurting the patient. Reduction is effected by the method described by Sir Robert Jones, care being taken to increase the deformity before attempting to restore the fragments to the correct alignment. In reducing the fracture, particular attention must be paid to the correction of the backward tilt of the lower fragment. This is even more important than the correction of the backward displacement, and, if not accomplished, will invariably result in a weakened wrist (Fig. 17).

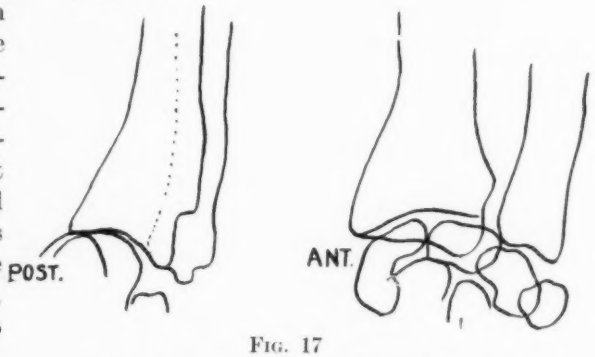


FIG. 17

Note backward tilt of radial articular surface.

It will be seen from the diagram that if the backward tilt is unreduced, the flexor tendons act at a disadvantage. They do not pull in their normal straight line, and this possibly affects the strength of the joint. But it will be seen also that the radial articular surface faces backwards, and does not, therefore, maintain its correct relation to the carpus. As was first pointed out to me by Mr. H. A. T. Fairbank, herein is the chief cause of the weakened wrist. The pull of the long tendons passing over the joint tends to make the carpus slip backwards over the now obliquely disposed radial articular surface. For this reason the muscles act tentatively,

and not to the full extent of their power, and the natural consequence is a weakened joint. The diagram shown is from a case which has since been operated upon with correction of this backward tilt.

Choice of Splint. I have no splint to offer. Many ingenious ones have been devised for the treatment of Colles' fracture, all with the aim of keeping the wrist in palmar flexion and adduction. Most, however, possess the one great disadvantage in that they are made of aluminium and prevent x-ray examination after reduction, a fact which, in my opinion, excludes them from serious consideration. There seems little doubt that Carr's splint is the most desirable, and can, when properly used, be as efficient as any. It is cheap, and easily made; it is comfortable and does not hamper finger movements; lastly it is wooden, and permits of x-ray examination.

The forearm, after reduction, is placed on the splint, which is covered by a very thin layer of wool. One pad of wool in addition is arranged under the lower end of the proximal fragment. The height of the pad can be varied to suit each individual case, and the extent of palmar flexion required thereby adjusted. A second pad is carefully placed over the distal fragment to maintain its position and prevent it from slipping back. With the arm held on the splint by an assistant, fixation is obtained by means of two narrow strips of adhesive plaster. One, the first applied, passes over the pad on the distal fragment to secure the latter firmly in position, and a second is placed higher up the forearm. A calico bandage is bound over all, one turn passing between the thumb and first finger, and after ascertaining that the circulation in the fingers is unimpaired, a lateral x-ray is taken, and the x-ray examined before the patient leaves. A poor result, particular attention being paid to the backward tilt, will necessitate a further attempt at reduction, which should not be delayed for more than a few hours.

The after-treatment. The whole question of after-treatment depends upon the optimum time for the commencement of massage and movement. Is early massage justifiable? The great danger of early massage lies in the risk of reproducing the displacement. Massage, as usually practised, consists in kneading the back of the forearm, thus pressing the upper fragment forwards and thereby inviting a recurrence of the backward displacement and backward tilt of the lower fragment. I admit that if reduction is perfect, so that each denture of one fragment fits into the correct serrature of the other fragment, recurrence is not likely. But such perfection is not often the lucky outcome of manipulation.

Those who advocate early massage claim that it accelerates recovery by maintaining a healthy condition of the underlying muscle. But surely no massage can be so beneficial in this direction as actual contraction of the muscles themselves, and this can readily be effected by urging the patients to move their fingers freely while still on the splint. In this way, the risk of impairing good reduction is obviated.

Massage should not, then, be recommended until the callus uniting

the fracture is becoming firm—a minimum of fourteen days in the average case—and must even then be of the gentlest nature.

The same dangers attending too early massage attend too early movement at the wrist. The period of immobilization depends to some extent upon the age of the patient—the older the subject, the greater the need for early movement. Little anxiety need be felt with regard to children, who, unless the deformity is gross, will always regain full movement. In the type of patient under discussion i.e., those liable to backfire fractures, it is desirable to steer a middle course. Time should be allowed for the uniting callus to become firm, so that risk of displacing the fragments is obviated. Eighteen days is an average time to allow. Movement at first must be entirely passive, the masseur grasping the forearm firmly over the lower fragment, and gently raising and depressing the hand. The greatest care must be exercised that the movement is taking place at the joint and not at the site of the fracture. Active movement at this early date is contra-indicated. It cannot be controlled, and the action of the extensor tendons when the forearm is not on the splint tends to pull back the lower fragment and reproduce the original displacement. After twenty-one to twenty-eight days the splint is replaced by a sling, which is worn for a few days.

Results. It is difficult to state the time of convalescence in cases of fracture, because there is no standard test of efficiency, and accepted levels vary. Moreover, in this series, only those cases of Colles' fracture which were due to backfire, seven in all, appear, and an average of this number is without value. It is proposed in another communication to give the figures for all cases of Colles' fracture which have been treated.

Operative treatment. Open reduction is indicated:

1. In cases where several attempts to reduce the fracture by manipulation have failed.

2. In old standing cases where there is a weakened wrist due to an uncorrected backward tilt.

(1) It is unusual to have occasion to operate early upon a Colles' fracture, for a good position of the fragments is usually obtained by manipulation if the case is seen soon enough, and I have no case to quote in which operation to reduce the fracture in its early history was indicated. The separation of the radial epiphysis—the Colles' fracture of children—is far more difficult to reduce by manipulation and to keep in a corrected position, and the early operation is sometimes essential.

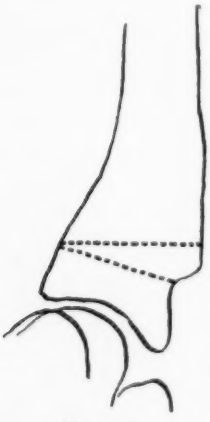


FIG. 18

Wedge-shaped osteotomy for correction of backward tilt.

FIG. 19

Curved osteotomy for correction of backward tilt.

(2) Fractures as much as three weeks old can sometimes be reduced by manipulation alone. For this purpose a Thomas wrench may be used, as recommended by Sir Robert Jones in "Injuries to Joints". But the method is not one which will meet with universal approval. The correct use of a wrench is an accomplishment difficult to acquire. Even in correction of talipes, despite the well protected arteries and nerves of the foot, wrenching is not without danger. In the case of the wrist, with its exposed vessels, and the ulna and median nerves, the dangers are enormously increased. The pressure exerted upon these structures in applying a Thomas wrench must of necessity be considerable, and I would hesitate to incur the risk involved. Open operation is much safer, and, in old standing cases which cannot be corrected by the hands alone, is the method of choice.

Technique of the Operation. An incision three inches long is made along the radial border of the forearm upwards from the styloid process. The supinator longus muscle and radial nerve are exposed and retracted. The extensor ossis metacarpi pollicis and extensor brevis pollicis are just visible passing downwards and outwards to the thumb. At this point the bone is exposed. The periosteum is incised above and below the fracture, levered away from the bone and retracted. The next stage depends upon the state of the union of the bone.

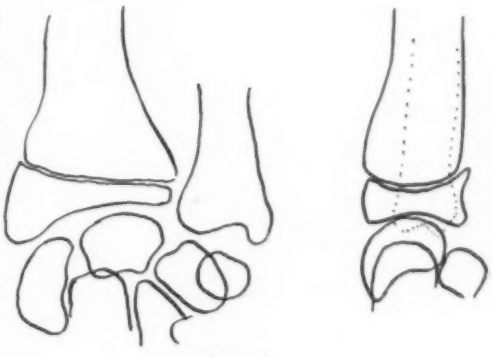


FIG. 20

X-ray of case after operation. For x-ray before operation see Fig. 17.

1. If the callus between the fragments is soft it is cut through and the ends of the bone examined. Any irregularities likely to prevent reduction are removed, and the fragments brought together in good position.

2. If the fracture is of old standing, and firm bony union has taken place, an osteotomy through the malunited fracture will be necessary. This may be done by an ordinary linear osteotomy, after removing any excess of callus. By this method backward displacement of the lower fragment will be readily correctable, but it will be difficult to overcome the backward tilt. To do this satisfactorily, a small wedge of bone will have to be removed from the palmar aspect of the proximal fragment. This method will involve some additional shortening, however, and it will be difficult to gauge the exact amount of bone to remove in order to get the radial articular surface facing exactly forwards (Fig. 18).

A more satisfactory method is as follows:—

The bone at the site of the fracture is cut through with a curved gouge. The surfaces of the fragments are so fashioned that the upper is convex and the lower concave, the one fitting accurately with the other. In this way,

a false ball and socket joint is made. The distal fragment is now rotated forwards so that the backward displacement is eliminated and the radial articular surface faces forwards at right angles to the long axis of the radius (Fig. 19).

No plate is necessary, and the periosteum is stitched over the fracture and the skin incision closed. The forearm is now put up in the carefully corrected position on a Carr's splint, and x-ray examination is made the following day to ensure that the position is satisfactory. After-treatment is the same as already enunciated, except that massage and movement are deferred for a week longer.

CASE REPORT

E. J. K.—Age 26. Fracture lower end of right radius in December, 1923, when starting car. Treated in County Hospital. Fracture set and splint worn for ten days. Since then has only been able to use right arm for light work. Admitted into King's College Hospital on December 1, 1924. Hand displaced backwards and rotated backwards with the lower radial fragment but not abducted. Styloid process of radius on level with that of ulna. Flexion and adduction limited at wrist. Supination impossible. X-ray (see diagram) show marked backward displacement of lower fragment, with backward tilt. No lateral displacement. Operation December 4, 1924. Curved osteotomy and correction of displacement. Discharged December 19, 1924 (Fig. 20).

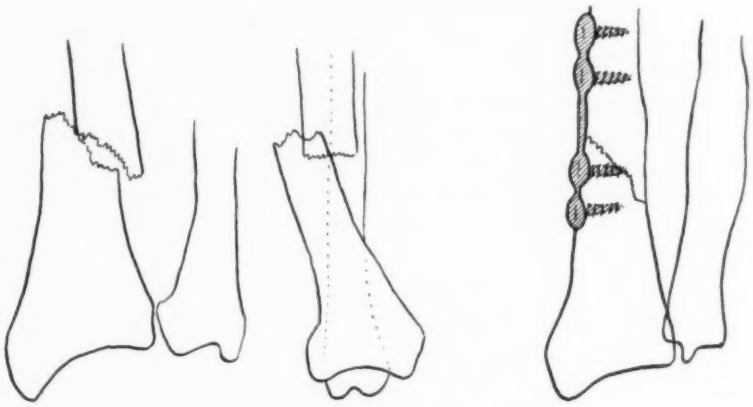


FIG. 21

Before and after operation.

II. *Fracture High up on the Radial Shaft.* In this type of backfire fracture, the lower fragment is with the carpus carried backwards. The extreme upper lip of the lower fragment may be displaced in front of the proximal fragment. The correction of the backward displacement is, on account of the size of the fragment, readily effected under an anæsthetic. Either a Carr's, or a posterior angular splint with a short anterior splint, is used. The after-treatment is similar to that adopted in Colles' fracture. There is this difference, however, in that there is less danger of the distal fragment slipping back into malposition. It is far easier to control than the distal fragment of a Colles' fracture on account of its size. Early massage

and movement need not, therefore, be feared so acutely as in the Colles' fracture, and the masseur may commence treatment in twelve to fourteen days.

Operation will be indicated:

(1) If there is marked and irreducible overlap.

(2) In old standing cases in which the backward tilt is uncorrected, and will not yield to manipulative methods.

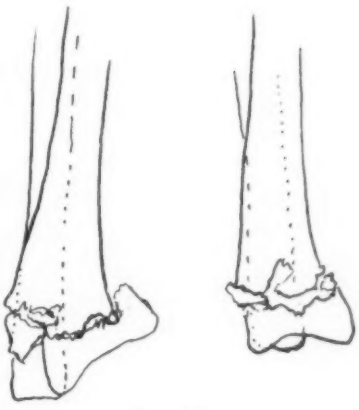


FIG. 22

Lateral view before and after operation (X-ray taken through plaster and difficult to trace accurately).

In the majority of cases with marked overlap it is impossible by manipulation to extend the fragments sufficiently to get the fractured surfaces into apposition. The radius is difficult to manœuvre owing to the presence of the ulna, which prevents the manipulator's fingers from grasping the affected bone firmly enough to exercise any forcible control. If the overlap cannot be reduced, the treatment of choice is, without any doubt, operation. Good functional results are frequently obtained, as is well-known, even though overlap be allowed to persist. But there is always anatomical deformity and an unsightly forearm as a result. But neglected overlap is always a potential source of difficulty and danger. The convalescence may be increased considerably, delayed union, and maybe non-union from interposition of muscle, tendon or fascia, may occur. There is the likelihood, too, that operation will have to be resorted to in the end,—an operation made so many times more difficult by delay.

Technique of the Operation. (1) The fracture is exposed by an incision four inches long on the radial side of the forearm, commencing half an inch above the styloid process. The supinator longus is identified, and retracted, exposing the bone. The fragments are cleared of newly formed callus, and brought into alignment with bone holding forceps. If it is thought that the fragments will remain in position without being held, no plate need be used.

The fracture, may, however, be oblique, and if left without fixation the surfaces will tend to slip, and reproduce the overlap. For this reason it is best to adopt some means of mechanical fixation, and for this purpose a Lane's plate will be found the most efficient instrument. A small four-holed plate is used, two holes above and two below the fracture. The plate may be fixed on to the outer surface of the radius, where it will be covered over by the supinator longus. A Carr's splint, or a posterior angular splint with a short anterior piece reaching from the wrist to the bed of the elbow, may be used. After the stitches are out, the splint may be substituted for plaster with the arm fully supinated. Movements and massage may be commenced in three weeks, the plaster being bivalved.

CASE REPORT

P. R.—Backfire fracture on January 27, 1925. For position see diagram (Fig. 21). Admitted to King's College Hospital and bone plated on February 12, 1925. Back at work on April 14. Movement at wrist then full, and little difference between hand-grips.

(2) The malunited fracture is exposed as in (1). A linear osteotomy is performed at the point of union. If there is any appreciable shortening the osteotomy should be oblique and an attempt made to increase the length by sliding the distal fragment down, or the step method may be tried. There is usually little to be gained by these measures, however, and a straight cut across the bone will be in most cases sufficient. The deformity is corrected, and a plate may be applied if thought necessary.

CASE REPORT

C. M.—Age 40. Fracture of radius high up on shaft when starting car on September 30, 1924. Seen November 18, 1924. Malposition uncorrected. Operation November 29, 1924. Osteotomy of radius performed, and plate used to secure fragments. On March 8, 1925, movement at wrist almost full, but slight limitation in all directions. Grip not quite so strong as that of left hand.

III. *Fracture Through the Lower Epiphysis.* Reduction is attempted as for a Colles' fracture. On account of the very small size of the distal fragment and the amount of rotation often present, it may be a matter of great difficulty, not only to manipulate the fragment into the correct position, but to maintain it once this has been achieved. No attempt should be made to give early massage and movement to these cases. Misplacement of the lower fragment will be the inevitable result, and no ill effects may be feared following prolonged mobilization. The best method, without doubt, is to use a plaster splint as soon as the swelling attendant upon the fracture has subsided. This is particularly desirable in fractures of this nature in young children. No method is so efficient in keeping the arm at rest, and the discomforts and general nuisance of a splint to a child, who cannot be expected to appreciate its value or attempt to keep it in the correct position, will be avoided.

In the young adult, the plaster may be removed in three weeks and massage and movements commenced. In a child, after a month's immobilization, the arm may be allowed to go free, and there is little need for the masseur's attention. Movement at the wrist rapidly returns without any set form of treatment.

If reduction cannot be effected by manipulation operation is advised. None of these cases of separation of the epiphysis due to backfire needed operation. The case cited below will serve as an example should operation become necessary. Care must be taken to get perfect apposition. A plate is to be avoided. A Carr's splint may be used, replacing it by plaster-of-Paris when the stitches are out.

CASE REPORT

M. L.—Age 5. Fell on to right hand and separated lower epiphysis of radius on November 27, 1919. Admitted to King's College Hospital February 27, 1920. Open

operation. New bone between fragments removed and correct alignment obtained. A Carr's splint was applied, replaced by plaster-of-Paris when the stitches were removed. Result — perfect movement, there being no difference between the two wrists (Fig. 22).

IV. *Other Types of Fracture.* Little need be added with regard to the treatment of other types of fracture. In fracture of the styloid process there is rarely any displacement, and massage and movement may be commenced after a fortnight's immobilization on a Carr's splint.

I wish to thank Mr. H. A. T. Fairbank, the Head of the Orthopaedic Department at King's College Hospital, for his kindly help and advice in the preparation of this article, and both Mr. Fairbank and Mr. St. J. D. Buxton for allowing me to make full use of their cases. My thanks are also due to my brother, Mr. Anton Edwards, for his assistance with the many diagrams.

TRACTION APPARATUS USED IN CORRECTING EQUINUS DEFORMITIES

BY ALBERT E. FLAGSTAD, M.D., ST. PAUL, MINNESOTA

Equinus deformities are seen fairly frequently. The correction of this deformity may be accomplished by repeated cast application, wrenching, closed or open tendon lengthening.

Repeated frequent changing of cast, correcting the deformity at each application, is undoubtedly the safest non-operative procedure; however, this is rather slow, tedious and is not without some discomfort to the patient.

Jones and Lovett [1] have described a method of applying a foot cast, then removing an elliptical piece of plaster just at the fold of the ankle. Into the plaster several straps are incorporated, one to the leg, a second to the foot. A third strap joins these two; by shortening the connecting strap at daily intervals the deformity is corrected.

The author has used a modification of this method in a few cases of equinus following infantile paralysis. The results have been most satisfactory.

The apparatus has several advantages:

First: It is more easily applied and less cumbersome.

Second: Amount of daily correction can be very definitely regulated and measured.

Third: Mild lateral or medial correction can also be accomplished by incorporating the plates to the anterio lateral or medial aspect of plaster.

Fourth: There is no danger of pressure from apparatus; the pull is always outward.

Accompanying photographs illustrate the method and apparatus. Plates are incorporated into the leg and foot portions of plaster. An elliptical wedge is removed and the turn buckle inserted.

Time required for correction is approximately two weeks.

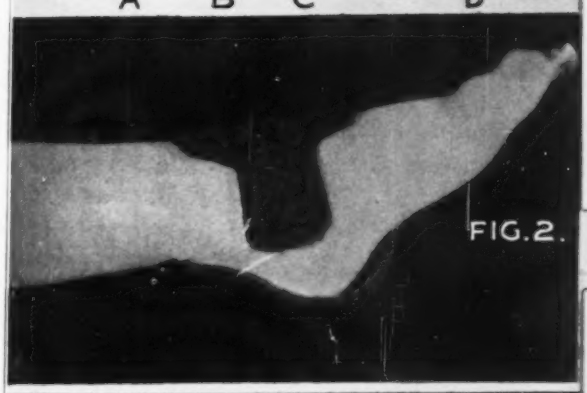
The following precautions are necessary:

First: Protect dorsum of foot, heel and malleoli; apply stockinette, felt and plenty of sheet wadding.

Second: Correct gradually, several turns daily; amount to be determined by the comfort of patient, circulation and sensation.

Third: It is preferable to keep patient in bed while correction is being done.

Fourth: Change cast after a week or ten days; if deformity is not corrected, apply new cast and wedge again. This apparatus is very inexpensive, easily made and can be used on repeated occasions.



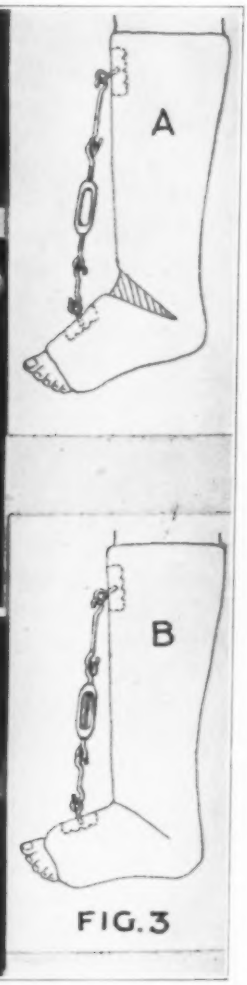


FIG. 1. A. Leg Plate.....No. 16 sheet steel 3 by 1½ in.
B. Foot Plate.....No. 16 sheet steel 2 by 1¼ in.
C. Turn Buckle.....Small size.
D. Hooks.....Steel rod 5/32 diameter.

FIG. 2. Shows the deformity. Two layers of stockinette. Protective felt on dorsum of foot with vacancy over dorsal vessels; also, strip of felt over heel.

FIG. 3. Drawing of instrument in position, showing (A) deformity and (B) correction of deformity.

FIG. 4. Apparatus incorporated in plaster; deformity corrected; wedge closed; foot at right angles.

REFERENCE

1. JONES, ROBERT AND LOVETT, R. W.: Orthopedic Surgery, New York, Wm. Wood & Company, p. 475, 1923.

OS CALCIS FRACTURES: A NEW METHOD OF REDUCTION

BY MAYNARD C. HARDING, M.D., F.A.C.S., SAN DIEGO, CALIFORNIA

Some eight or nine years ago the author was led by the poor results in os calcis fractures which he both obtained and observed to make a more careful study along the lines so ably described by Cotton.

The type of fracture under discussion is the "smash" fracture, where there is not only a transverse break through the body, but a crushing from above downward causing the bone to broaden until sometimes it projects as far as the malleoli. As is well known, these fractures frequently result in a high degree of permanent disability, for which several extensive operations have been advocated, but with uncertain results.

In the treatment of the fresh fractures Cotton's impaction with a mallet has been the most widely used method. It has always seemed to me, however, that there were two fundamental defects in the procedure: First, that mallet impaction (at least in my hands) cannot be done accurately. The under side tends to conform to the shape of the sand bag or other objects against which it is placed. Second, it is almost impossible to retain control of the posterior fragment during impaction, with the result that it may be found afterward to be riding too high.

The chief causes of disability are: (1) Broadening of the os calcis at the subastragaloid joint with the impingement on the malleoli, usually the outer. (2) Irregularity of that joint from callus or fibrous ankylosis. (3) Shortening and flattening of the heel with weight-bearing on callus instead of on the tuberosities. (4) Severe trauma due to fall. Several patients seen by the author have fallen twenty-five feet, landing on hard ground or pavement. The usual cause of persistent pain seems to be broadening with partial subastragaloid ankylosis.

For a clear conception of the problem, two x-ray views are needed, a lateral stereo centered on the internal malleolus, and a view from behind the knee. For the second the patient is placed prone on the end of the table with the foot in dorsiflexion, the plate against the sole of the foot. The tube is shifted so the central ray is perpendicular to the axis of the os calcis. The second is of great importance as it shows both lateral broadening and lateral angulation or displacement of the posterior fragment.

There are three things to do to effect a reduction: The posterior end of the heel must be drawn down so that weight will be borne on the tuberosities and not on the fracture line. The anterior end of the heel must be pushed up to restore the arch. The broadening must be corrected.

The knee is flexed over the end or side of the table. If the shoulders are slightly raised there is less strain, but this is not necessary. The time-honored method is that of pulling down the posterior fragment with tongs or

with a bar passed through in front of the Achilles' tendon. A moment's reflection will show that the bar does just what we do not want done. The Achilles' attachment is the fulcrum of the lever, and any traction downward in front of it will tend to draw down the anterior end of the os calcis instead of the posterior. Tongs may be placed far enough back to be effective, but the simplest and best way is to seat a sharp claw retractor into the skin at the back of the heel by a light blow. This gives traction at the most advantageous point. It is never necessary to cut the Achilles' tendon. Three points of counter pressure must be provided. On a stool with a screw top is placed a triangular wooden wedge such as is used for club foot manipulations. The stool is screwed up until the wedge presses firmly into the sole of the foot at the calcaneocuboid joint. The fore foot is sharply bent down with one hand while the retractor is pulled down with the other and as much correction as desired is made.

A cabinet maker's D clamp is now applied to the sides of the os calcis, the pressure points being protected by felt or rubber. The clamp is screwed in slowly at first to overcome the swelling. This is continued until the width is the same as that of the opposite heel, tested by removing the clamp, and applying it alternately to the two. Pressure should be made at several points for a short time. It will be found that when the clamp is well screwed in it can be used as a Thomas wrench. When the fracture is well reduced, subastragaloid motion can be demonstrated to nearly normal range.

If desired the clamp and retractor can be left in place until the plaster has been applied, but this is not necessary, as there is little tendency to displacement in this position. A very light cast is put on from the toes to mid-thigh with the foot in extreme plantar flexion and the knee at one

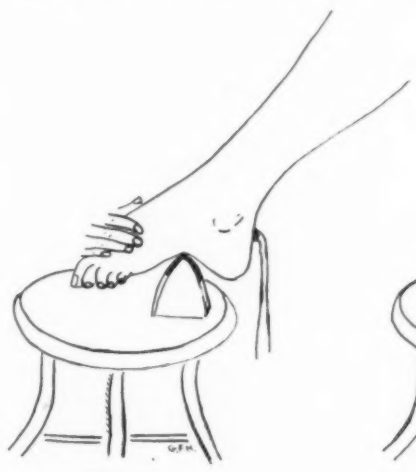


FIG. 1

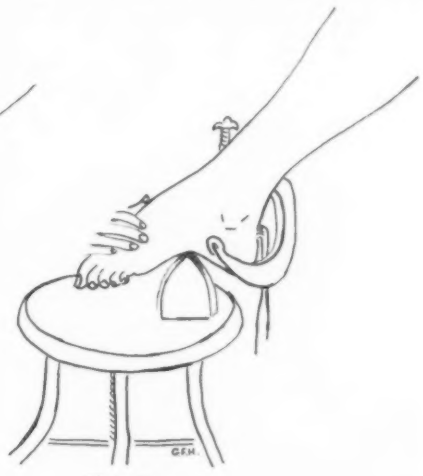


FIG. 2

FIG. 1. Correction of vertical displacement over a wedge by downward traction on the heel and counter pressure over the dorsum of the foot.

FIG. 2. Application of clamp to reduce lateral displacement while plantar correction is being maintained.

hundred and thirty-five degrees. This is to maintain relaxation of the Achilles' tendon. The plaster is pressed firmly against the sides of the heel while setting. The cast should be left on about three weeks. The patient can then bear a little weight on the ball of his foot if no pain results. Full weight-bearing should not be allowed under three months, and should be strictly supervised. A felt arch usually adds to the patient's comfort.

So far I have treated fifteen cases by this method, — two of them bilateral — and all of these patients are at work. The average length of disability in these cases has been only five months, which is about one-half the usual time. None of these feet have had to be operated on subsequently.

This operation has proved sound in principle and easy of execution. Its success in the hands of others as well as in my own warrants its trial in place of the procedures now in vogue.

TRANSPLANT OF THE UPPER EXTREMITY OF THE FIBULA TO REPLACE THE UPPER EXTREMITY OF THE HUMERUS

BY ROBERT McE. SCHAUFFLER, M.D., KANSAS CITY, MO.

The patient was a girl fifteen and a half years old. One and a half years before, she had suffered from an acute osteomyelitis involving most of the shaft of the humerus, with a secondary septic arthritis of the shoulder. Radical operation was performed at the wrong stage. When examined by me in June, 1919, the maximum regeneration of the upper half of the humerus was represented by a tapering spike, which failed by one and a

FIG. 1

Showing loss of head and part of shaft of humerus by osteomyelitis. Maximum regeneration one and one-half years after operation.

half inches to reach the glenoid. Examination of a series of earlier x-rays showed that atrophy of the new bone was beginning from lack of use. There had been much injury to the muscles about the shoulder and the arm hung limply at the side, as if suspended by a strap.

Operation was performed on July 16, 1919. The upper end of the inverted icicle-like humerus was exposed and freshened. The shrunken capsule of the shoulder was unfolded as much as possible. The upper extremity and one inch of the shaft of the fibula was removed, with a stump of the biceps tendon attached. The shaft of the fibula was flanged below

FIG. 2

Showing transplant of head and upper shaft of fibula to replace missing head and upper shaft of humerus. X-ray six weeks after operation.

FIG. 3

Showing transplant six months after operation.

and mounted on the humeral spike, the tip of which passed into the medullary cavity. The remains of the capsule and certain stumps of the former muscular attachment were gathered together in a purse string suture, which was anchored to the stump of the biceps tendon.

In the fourth postoperative month the patient fell heavily on the shoulder and fractured the upper humeral spike. This united in five weeks.

At the end of six months it seemed evident the transplanted bone was living and passive motion in the shoulder was good and active motion

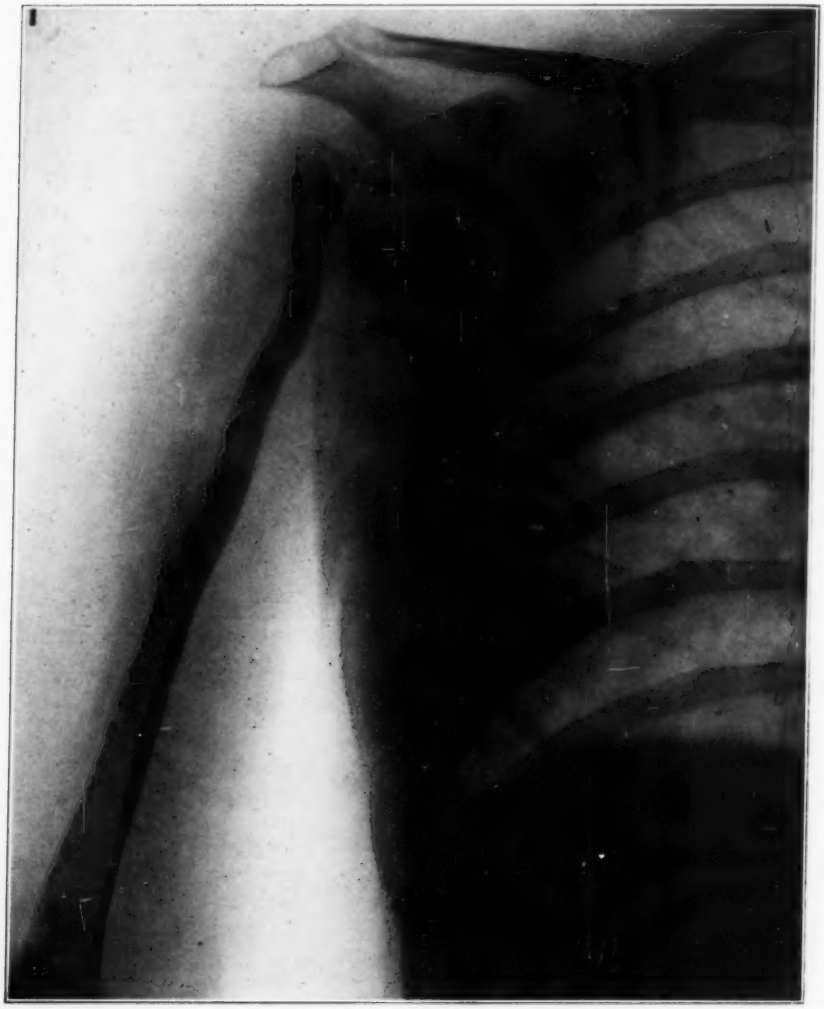


FIG. 4

Postoperative result five years after transplantation.

beginning. It was planned a little later to do an operation to further repair the damaged muscles, perhaps bringing down a slip of the trapezius.

Before this could be done the girl ran away and was married. The author was unable to locate her until two years ago. Figure 4 shows the x-ray appearance five years after operation. The articular facet on the transplant corresponds to the free range of motion in the lower planes, with voluntary abduction to only sixty degrees.

The patient was urged to have a reparative operation on the soft parts, but replied that she was able to do her housework and take care of her children, that her husband was satisfied with her and that she was "not going to fool around with any more doctors".

BONE SARCOMA—PERIOSTEAL AND DIFFUSE TYPE, AND THEIR DIAGNOSIS FROM BENIGN LESIONS

BY JOSEPH COLT BLOODGOOD, M.D., BALTIMORE

NOTE: This is the second in a series of articles prepared for the *Journal* by Dr. Bloodgood on the general subject, How to Diagnose and Treat a Bone Lesion. *Editor.*

In a previous article in this Journal I have discussed central lesions and called attention to the rarity of sarcoma as a central lesion of bone; that is, one giving the picture that the bone cyst does in the shaft, or the giant-cell tumor in the epiphysis. The malignant central lesions of bone are of metastatic origin, or due to the rare multiple myeloma. When the metastatic carcinoma and multiple myeloma are observed and there is a lesion of but a single bone, there is great difficulty in differentiation, and I have tried to bring out these points in my previous paper.

Periosteal and Diffuse Sarcoma. When the palpable mass is distinctly on the shaft of a bone, like an exostosis, and when the x-ray shows new bone resting on the shaft, we have to bear in mind that trauma, infections, and neoplasms may all three produce an ossifying periosteal growth, with or without any visible changes in the shaft. There is, therefore, a traumatic, infectious, and neoplastic ossifying periostitis, with and without bone formation or bone destruction visible in the x-ray.

When we are confronted in the x-ray with a diffuse lesion, for example, like sclerosing sarcoma, we must bear in mind that the non-suppurating, sclerosing osteomyelitis may somewhat resemble sclerosing sarcoma. In both sclerosing sarcoma and this type of osteomyelitis there is evidence of new bone in the involved area, and as a rule these dark areas of ossification predominate in the x-ray picture.

Method of Attack. In the paper on central lesions of bone, in which the bone shell is intact, with and without fracture, the definite conclusion was suggested that delay in operative exploration under x-ray therapy adds no risk. By taking repeated x-ray pictures one can tell whether there is non-union of a fracture, or further thinning and expansion of the bone shell, or evidence of lack of ossification in the central tumor area. If the lesion is in the shaft of a child under fifteen, one can be quite certain of the diagnosis of a benign cyst, and there need be no x-ray treatment during the period of observation. Lack of ossification is an indication for operation. Recent experience has shown that x-ray treatment may be helpful in the giant-cell tumor. Recently four cases of central giant-cell tumor of the epiphysis have come to my attention, two of which gave me an opportunity to observe the effect of deep x-ray therapy. In one, in which the bone shell was intact, part of it disappeared under the treatment and the tumor in

the upper end of the tibia got larger, and at operation the bone shell was very thin and in places destroyed. In the second case the bone shell surrounding the tumor in the lower end of the radius was very, very thin, and the palpable tumor quite soft when the x-ray therapy began, but under radiation the swelling contracted and, on palpation, the shell grew firmer, as if it were ossifying. However, the x-ray showed no ossification but only contraction of the shell and, at operation, after two months' treatment, there was no ossification.

When a central tumor is explored and found to be not a bone cyst, the tumor tissue within the bone shell should be thoroughly removed with thermal and chemical cauterization, and in chondroma and myxoma and chondrosarcoma, if it can be demonstrated that the bone shell is involved, then there should be resection and bone transplantation. This is not necessary in the giant-cell tumor, even when the soft parts are involved.

The method of attack on the periosteal and diffuse lesions of bone is entirely different. It is based upon the observation that, at the present time, amputation for lesions of the lower extremity below the upper third of the femur and resection for lesions of the upper extremity offer more for a permanent cure in sarcoma than radiation. If the bone lesion is in the upper third of the femur, or in the upper extremity, and of sufficient extent to rule out resection, radiation should be the method of choice, and should be continued until amputation becomes a necessity to relieve pain.

Therefore, when the lesion—periosteal or diffuse—is where it can be resected, or below the upper third of the femur, where amputation becomes the method of choice, and if the clinical picture, x-ray, and other laboratory findings cannot absolutely rule out sarcoma, there should be no delay. The object of the operation is to explore, get a piece for frozen section, stain with polychrome-methylene blue, and then decide the nature of the lesion. If it is sarcoma, resection or amputation is indicated.

The method of attack, therefore, is different from that in the central tumor.

Syphilitic Periostitis and Osteomyelitis. In the periosteal and diffuse lesions, if there is a positive Wassermann, intravenous therapy should be given a trial. Even when the Wassermann is negative, there is no objection to a provocative dose, but not much time should be lost when the Wassermann is negative. A brief review of my personal experience may be helpful here.

Up until five years ago, I saw an increasing number of syphilitic bone lesions, usually single and without evidence of syphilitic involvement of other tissue. There are records of such cases in both children and adults. When the Wassermann was positive, there was immediately—within ten days—definite improvement in the local bone lesion from intravenous therapy. In about six cases, all recorded more than ten years ago, the Wassermann reaction was reported negative, but in these cases the technicians were inexperienced, and no second test was made. Because of the localization of the lesion—clavicle or upper extremity—or due to the

x-ray picture, these patients were given intravenous salvarsan, and, to our surprise, the bone lesion healed, and the patients are still well. But since 1920 syphilitic bone lesions referred to me for diagnosis are growing less, while all other diseases of bone are increasing in numbers. It seems natural to infer from this that the Wassermann tests are now more accurate, and these patients are being treated before reference to a surgeon for diagnosis. In the past ten years there has been no bone lesion, with a negative Wassermann, that was helped by intravenous therapy. We have also recently noticed that there is not a recorded example of sarcoma of bone in which the Wassermann has been positive, nor one associated with active tuberculosis of the lung, nor one in which there had been a recent and definite focus of infection; such as a carbuncle, multiple abscesses about the roots of teeth, infected tonsils, adenoid or sinuses, or recent attack of typhoid fever. This is a very important thing to bear in mind. Our laboratory reports are becoming more accurate, especially the Wassermann tests; our histories are more helpful in diagnosis, and syphilitic periostitis and osteomyelitis are disappearing from the bone lesions mistaken for sarcoma.

Biopsy. There must be an exploratory operation to determine the pathology in the central tumor, because of non-union of fracture, if present, or further thinning and expansion of the bone shell, and in periosteal and diffuse lesions, because of the possibility of sarcoma and the localization of the growth which places the lesion among those for which resection or amputation offers more than radiation. This operation should not be undertaken until the patient, if an adult, or the parents or guardians of the child, have consented to resection or amputation, which are the operations of choice in the periosteal and diffuse sarcoma, and may be the operations of necessity in central lesions like chondroma, myxoma, myxochondrosarcoma, metastatic tumor, and even, in some instances, myeloma.

The next vital question is: Can biopsy be done in stages? That is, is it wise to excise a piece, close the wound, and then wait for the pathological report, if only for a few days? In my report in the Journal of Radiology for March, 1920, are included two cases of periosteal sarcoma of the diffuse type which had remained well seven years after amputation. In one, there had been a biopsy with an interval of about two weeks before amputation; in the other, there had been no exploratory incision. Since that date—1920—twelve cases of periosteal or diffuse sarcoma have reached the five-year limit without signs of recurrence, and in two there was biopsy with an interval of a few weeks. In all myxomatous tumors of bone explored and removed piece-meal there has been recurrence and ultimate death from metastasis. In those subjected to resection and amputation without this previous piece-meal removal, the patients have remained well. Biopsy is therefore a dangerous procedure in myxoma—and the myxoma may be both a central and periosteal lesion.

It is safer for the patient if diagnosis is made at the exploratory incision. There must be present at this operation a single person or a team trained and experienced in interpreting gross pathology as exposed at

operation, in the technique of making and staining a frozen section, and in interpreting the cellular pathology with all the powers of the microscope including the oil immersion.

If this is impossible, it is advisable that the x-ray and history be sent to those more experienced in bone lesions for diagnosis and help before anything is done. Then, if biopsy must be done and the surgeon and his team are unable to make a diagnosis, it is better not to amputate or resect but to cut out a small piece with the cautery, disinfect the wound with carbolic followed by alcohol, and then with zinc chloride; then to close the wound, leaving in it a bit of gauze saturated with alcohol. A report on such a piece of tissue should be obtained within five days, when the necessary operation can be done.

Theoretically, this is the way biopsy should be done when the diagnosis cannot be made at once and the operation performed then and there. This suggestion is made chiefly to save unnecessary amputations and resections, because the chances of a cure in sarcoma are small; in central sarcoma there are no five-year cures up to date. In periosteal and diffuse sarcoma the number of cures is rapidly increasing since 1920. The evidence seems to show that this is due to early intervention. These patients see their family physician at once. The general practitioner realizes the importance of an immediate x-ray and laboratory examination. The chief dangers now are selecting radiation when it should be operation, pushing radiation too far in central lesions, or in selecting operation when there should be radiation. There is also another danger: these patients are coming under observation not only of the general practitioner, but of the specialist, at such an early stage that both are finding greater difficulties in diagnosis, not only from the x-rays, but, at operation, from the gross and frozen-section findings. The responsibility has increased with the difficulties of diagnosis. Having educated the people to come at once, the medical profession should attempt to educate itself to be competent to act at once. There must be no unnecessary and mutilating resections and amputations. Yet these operations should be done and performed quickly when they promise most for a cure.

At the present writing, the weakest link in the chain is the faulty technique in making and staining the frozen section, and in the lack of training and experience in the one who interprets the microscopic picture.

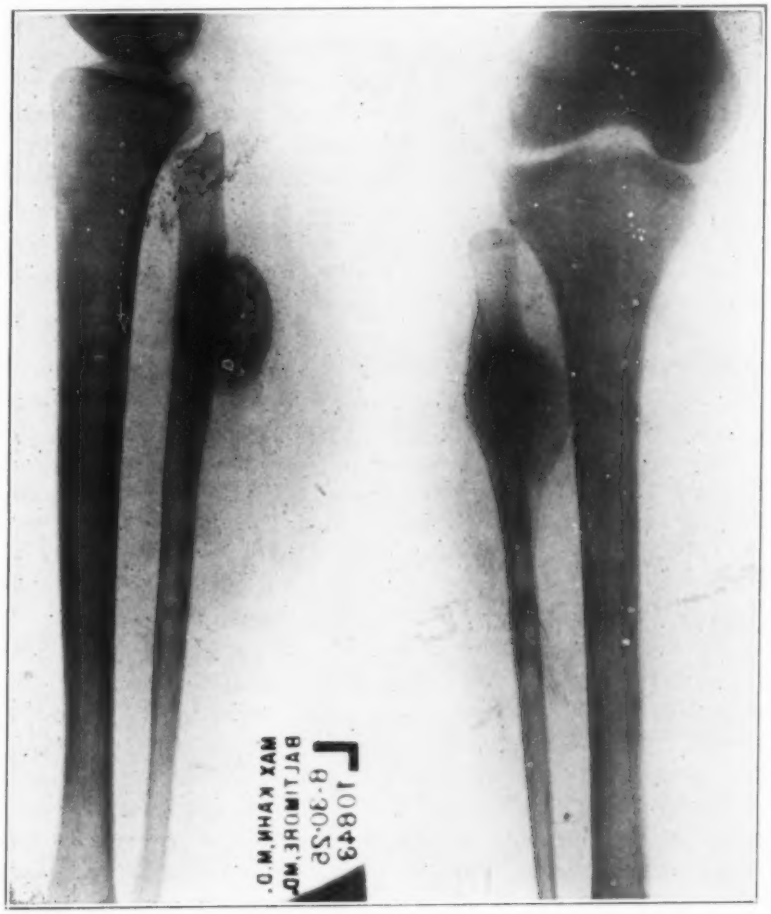
Bone Formation and Bone Destruction in Bone Lesions. There are two types of bone formation: The first is *periosteal*, which is easily seen in the x-ray, and should be palpable if carefully felt. We all are studying intensely the periosteal bone formation to determine if we can distinguish from this shadow alone traumatic, infectious, and neoplastic lesions. There is no doubt that they may be divided into three groups.

In one the x-ray alone tells when the lesion is benign or malignant. In the doubtful group there must be biopsy, and I will discuss a few cases of periosteal and diffuse lesions of the ossifying type, taking actual cases with the illustrations. The group of bone destruction without bone formation will be presented in a third paper.

The second type of bone formation is *endosteal*, as seen in the sclerosing sarcoma, sclerosing osteomyelitis, in the ossification of central bone lesions, especially the bone cyst, and in the intermedia and pin callus of fracture.

CASE 1. (Pathol. No. 36752.) Observed June 16, 1925. Miss F. V., aged fourteen. *Final diagnosis:* Benign bone tumor; exostosis of fibula, shaft, upper third, ossifying periostitis. Question between traumatic and infectious. *Operation*, July 21, 1925 (Bloodgood, St. Agnes Hospital): Exploration, partial removal. Frozen section—Benign. Wound closed. *Result* June, 1925—one year well; bone area getting smaller (Figs. 1, 2 and 3).

I explored this ossifying lesion of the fibula, because I was suspicious of possible malignancy and knew that if it proved to be sarcoma I could resect it. If the x-ray had indicated sarcoma without a doubt, resection without



a *b*

FIG. 1

CASE 1. Pathol. No. 36752. Benign exostosis, or benign ossifying periostitis, shaft of fibula. In *a* the dark cloud over the shaft suggests sclerosing sarcoma, but the picture in *b* in which the normal shaft shines through, shows that the cloud in *a* is explained by periosteal bone formation and not marrow sclerosis.

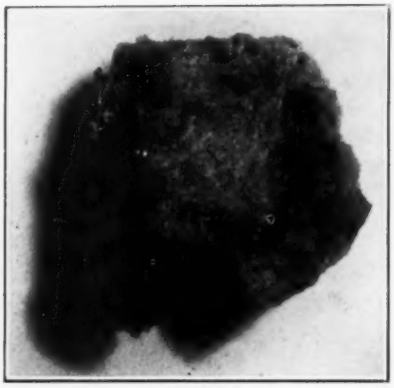


FIG. 2

CASE 1. Pathol. No. 36752. Piece of bone removed at exploratory operation on the area shown in Fig. 1. (Enlarged X 2.) Benign ossifying periostitis. Cortical bone to the left, that is, beneath periosteum. Bone to the right stripped from shaft of fibula. Between, cancellous bone with normal marrow fat and areas of inflammatory tissue. See Fig. 3.

exploration would have been the operation of choice.

X-ray (Fig. 1). This picture was taken June 30, 1925. In the lateral view (*a*), the cloudy, dark area over the shaft is not unlike that of sclerosing sarcoma; the sharp outline of the periosteal mass of bone above and to the side is that of a benign lesion, but the lower portion of the periosteal mass is not very distinct. When we look at the anteroposterior view (*b*), we can explain the cloudy area over the shaft in (*a*) as due to a shadow cast by a periosteal growth which would seem to rule out sclerosing sarcoma. The x-ray, on the whole, favors a benign lesion.

Clinical History. The patient is a young girl aged fourteen, in perfect health. All other examinations—physical and laboratory—were negative. As the girl is active in athletics at school and is very muscular, there is large opportunity for trauma. But neither the girl nor her parents can remember a definite injury. Yet, there was something in the beginning that would not be unusual after an injury in an athletic game in which the child's mind was occupied by the game. In October 1924, during the athletic season of the fall, she felt a soreness in the region of the present tumor on the fibula as if she had been bumped. As the girl can feel the bony growth now, the chances are that it was not there then. The first treatment was osteopathy, and the repeated traumas and manipulations of this therapy, without any examination or any x-ray, made the child more uncomfortable after each treatment. The next doctor put the limb in plaster without an x-ray examination. This relieved the discomfort. But when the plaster was taken off at the end of six weeks a bony mass could be felt. Then an x-ray picture was made and the diagnosis was *osteogenic sarcoma*.

The girl came under my observation with a series of x-ray plates taken between the period December 1924 and June 1925,—six months. For two weeks she had been receiving osteopathic treatment; for six weeks there had been rest in plaster. There is not much change in the bony growth between December 1924 and June 1925. My clinical impression was of a traumatic ossifying periostitis made worse by osteopathy, made better by rest, and that during the period of x-ray examinations there was no further bone growth; it had become quiescent.

The roentgenologist who had referred the patient to me, and who had suggested the diagnosis of osteogenic sarcoma, was one of our most experienced

specialists in this line, and when Dr. Max Kahn studied these plates with me, although we were rather inclined to the conclusion that the bone lesion was benign, nevertheless it was placed in the border-line group. While observing the patient for one month for further x-ray examinations, she was given x-ray therapy.

Palpation. On a number of occasions I palpated the bony mass shown in Figure 1. There was no involvement of the soft parts outside the bone. It felt like a benign bone growth—an exostosis or ossifying myositis of traumatic or infectious origin. Nevertheless I knew that on rare occasions neoplastic ossifying periostitis could feel exactly like the benign lesion.

Operation July 21, 1925. Why did we explore? Because, after repeated x-rays and palpation, we were unable to exclude sarcoma, and we knew that, if it were sarcoma, resection was possible and offered the most. When I cut down upon the bony growth shown in Figure 1, there was no infiltration of the soft parts. The soft parts had the same relation to it as to

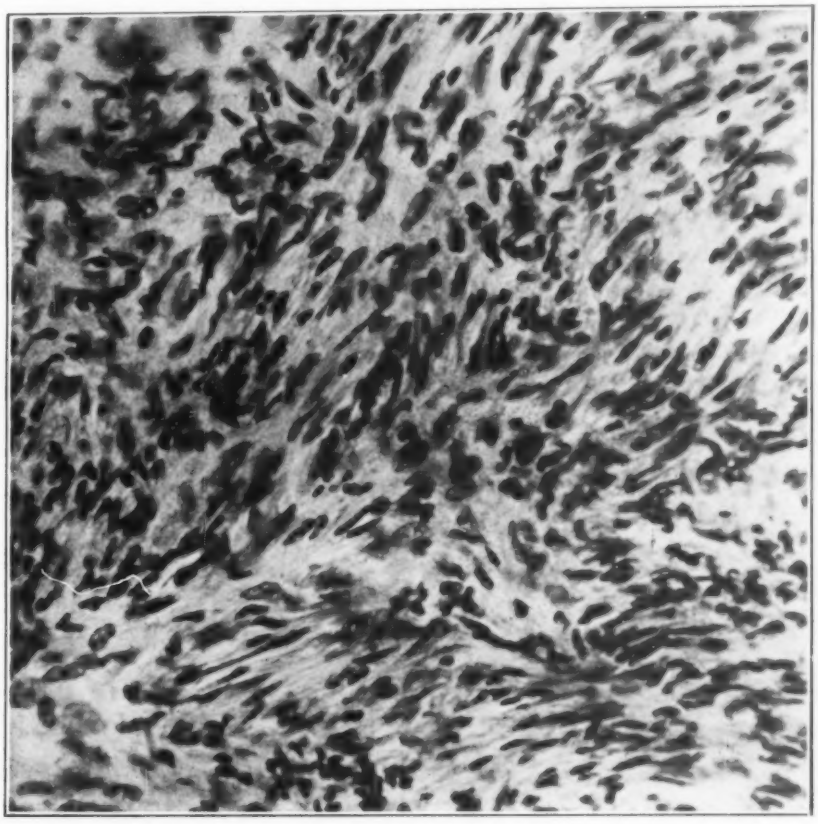


FIG. 3

CASE 1. Pathol. No. 36752. High-power photomicrograph of formalin section, eosin-haematoxylin stain. Chronic inflammatory tissue in fibrous area from bone in Fig. 2.

the normal shaft. When it was exposed it felt like the normal bone of an exostosis. The periosteum over this new growth of bone was continuous with the shaft above and below. The mass of bone surrounded the shaft. I then cut off a piece of periosteum and tendon next to the new growth of bone, because in a few cases of ossifying periosteal sarcoma resembling this case I had found sarcoma cells in the periosteum and tissue on top of the osteoid growth. My technician, Mr. Walker, brought the sections to me in four minutes, and there was nothing in the cellular picture even to suggest sarcoma. I then felt that we must examine the center of the bony growth, so I chiselled off the piece shown in Figure 2. The outer layer of bone was as dense as cortical bone, and no frozen section of this could be made. But the inner bone was cancellous, with here and there a larger marrow space. As shown in Figure 2, instead of fat there was a mass of fibrous tissue, perhaps 3 mm. or 4 mm. in diameter between the bone. The frozen section from this area is shown in Figure 3. This is a photograph of a stained, fixed piece of tissue. In the polychrome-methylene blue stain of the frozen unfixed fresh tissue, the cells are larger and the nucleus does not fill the cell as it does in Figure 3. In this freshly stained tissue there is less difficulty in distinguishing the fibroblasts and the plasma cells from the spindle and round cells of sarcoma. Compare this with Figures 6 and 11.

It is very difficult to have the trained photographer present at this operation to make the photomicrographs, but ultimately this must be done, because the differentiation between traumatic and infectious inflammatory tissue, on the one side, and neoplastic, on the other, must be detected at the operation and at the present time the polychrome-methylene blue stain of the frozen fresh tissue seems best. My previous studies of ossifying sarcoma, both of the frozen sections during operation and of the specimens at the laboratory, have clearly shown that, in sarcoma of both the sclerosing and periosteal type, definite sarcoma tissue could always be demonstrated in the tissue outside the bony growth; that is, the periosteum or the tissue replacing it. We could not find this periosteal tissue in this case. This, of course, was very helpful. Having concluded that the microscopic picture illustrated in Figure 3 showed inflammation, the nature of the operation for the benign lesion had to be selected. For sarcoma or for any suspicion of sarcoma in this case, resection of the upper end of the fibula with the cautery should have been done. What should be done for the benign lesion such as is shown in Figure 1? Complete resection seemed unnecessary. To have chiselled away all of the periosteal growth from the shaft might have been followed by a reformation larger than the present one. Therefore, having satisfied myself that the growth was not sarcoma, I left the remaining part untouched. Figure 2 is an enlargement of the piece which was removed.

The actual size of the piece removed is that of a twenty-five-cent piece.

At the present writing, one year after operation, the patient is well; x-rays have shown no reformation of bone; and the last x-ray shows that the bone is beginning to be absorbed.

In the Journal of Radiology (IV, 119–127) April, 1923, I reported a

group of traumatic, infectious and neoplastic periosteal bone lesions, and one of these, operated on by my friend, the late Dr. Le Conte of Philadelphia, has again been published by Dr. John R. Paul (Archives of Surgery, X, 185–195, January, 1925). I had this case in mind when I operated on the patient whose lesion we have just been considering. In Le Conte's patient the ossifying lesion occupied the upper end of the fibula. It was adherent to the tibia, so that when he resected it he stripped the growth from the tibia denuding some periosteum. Now this operation was not of sufficient extent for a sarcoma. In Le Conte's case bone formation took place in the defect chiefly from the tibia, and this bone formation continued until it had involved most of the muscles of the upper half of the tibia. The first operation was in 1919. Within two years there was a good deal of bone formation, and after four years the leg was amputated. Now, of course, this is a unique case, but we must bear in mind, when we operate for benign ossifying lesions, the possibility of performing an operation insufficient for sarcoma but which may be followed by this excessive bone formation. It was because of this possibility that I restricted the operation in this case. No one has had sufficient experience to tell whether the good result is due to management or good fortune.

Case 2. (Pathol. No. 36848.) Observed July 1925. Miss B. C., aged ten years. *Final Diagnosis:* Ossifying periosteal sarcoma of lower shaft of humerus; marrow cavity not invaded. *Operation*, July 10, 1925 (Bloodgood, St. Agnes Hospital): Exploration; frozen-section diagnosis: sarcoma; resection of lower end of humerus. Wound closed. *Second Operation*, 3 months later: bone transplantation. *Result:* 8 months, no recurrence, fair function (Figs. 4, 5, 6 and 7).

X-ray (Fig. 4). In the lateral view (*a*) the new bone formation is that of a traumatic ossifying periostitis with some suggestion of an ossifying myositis. But this new bone formation, to be of traumatic origin, is in an unusual position, as traumatic periostitis and osteomyelitis occur around the elbow joint in the great majority of instances. Yet, I have before me now (Fig. 8) a case in which the new bone formation which we know is of a benign type, resembles that in Figure 4. When we look at the anteroposterior view (*b*), we see a periosteal bone formation that is almost pathognomonic of a neoplastic disease. We have therefore in this case an x-ray picture of a border-line lesion, and exploration is justified, because if the lesion is sarcoma, resection and bone transplantation are the operations of choice.

Clinical History and Examination. I saw this patient with Dr. Thompson of Smithfield, Ohio, in my office July 9, 1925. There was a visible swelling, like a dome, on the outer side of lower portion of the arm which felt like bone. It was a spherical mass, as can be seen in Figure 4, and I could feel the normal shaft of the humerus above and below it. It felt like a benign bone growth. Yet, in the bend of the elbow there was tenderness, and there was some swelling of the forearm below, but no definite oedema. These are rather signs of a neoplasm. There was limitation of motion at the elbow to twenty degrees. The artery pulsated. Plates, taken by Dr.

a *b*

FIG. 4

CASE 2. Pathol. No. 36848. Ossifying periosteal sarcoma. For gross appearance see Fig. 5 and for microscopic section, Fig. 6. Periosteal bone formation in *a* resembles benign lesion; in *b*, it is typical of sarcoma. The dark cloud over the shaft explained by new periosteal bone; the marrow was not involved. See Fig. 5.

Ralph T. Robinson of Pittsburg, were compared with those taken in my office by Dr. Kahn. We were all inclined, on account of the shadow in Figure 4-*b*, to the diagnosis of sarcoma, and then, on repeated palpation, there seemed to be a soft-part zone resting on the bone, as if there were a capsule and a little fluid on an exostosis.

It is very important to record here that the symptoms have been present only two months. The patient was first seen by Dr. Thompson about one month ago, and x-rays were taken within one week. Both on palpation and in the x-ray, the periosteal mass is slowly enlarging, and restriction of motion has been present one month. There was no history of trauma. All other examinations were negative. It seemed to me that operation was urgent and imperative. This was performed at St. Agnes Hospital the next day, July 10, 1925. The surface of the tumor exposed was entirely different from that in Case 1 (Figs. 1, 2 and 3). We did not palpate bone, but soft tissue. It could have been the capsule of a bursa over an exostosis, but when we nicked it with the cautery (Fig. 5) it was evidently a new growth, and the frozen section revealed a definite sarcoma. Compare Figure 6 with Figure 3. The area exposed was burnt with the cautery, and the piece shown in Figure 5 resected, also with the cautery. On top of the tumor, as shown in the illustration, a zone of muscle was left. Tumor tissue was seen and exposed only over an area smaller than a ten-cent piece. The cut into the tumor was made with the electric cautery. The wound was closed, the arm was put up in extension later in an aeroplane splint. The graft was introduced at a second operation on October 20, 1925. It is remarkable what good function this patient has as reported by her parents and doctor.

When we compare the gross appearance (Fig. 5) with the x-ray shown in Figure 4, it tallies with the conclusions from palpation. The palpable

FIG. 5

CASE 2. Pathol. No. 36848. Longitudinal section through piece resected from lower end of humerus, shown in Fig. 4. Note periosteal ossifying sarcoma resting upon almost normal cortical bone; marrow cavity apparently uninvolved. For section see Fig. 6.

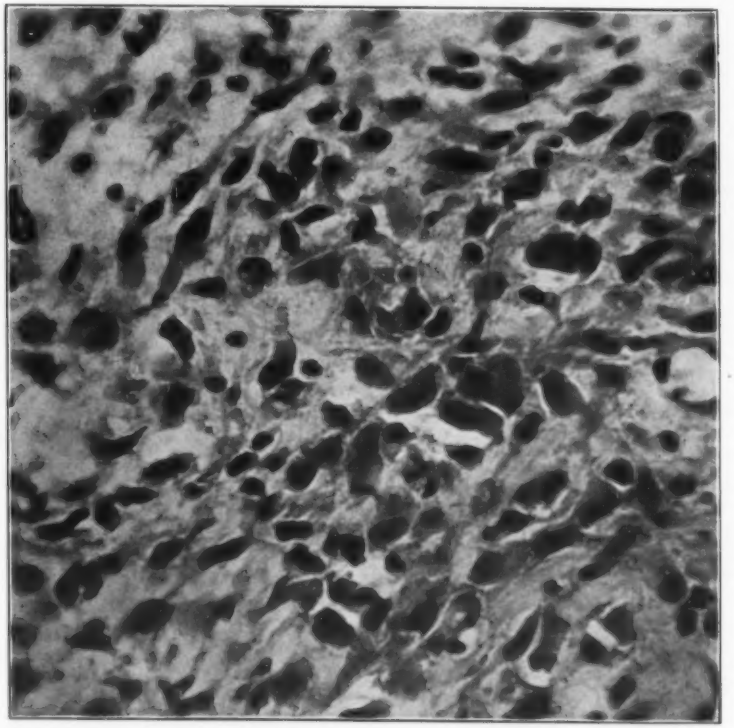


FIG. 6

CASE 2. Pathol. No. 36848. Sarcoma, osteogenic; chiefly, spindle and round sarcoma cells. No giant cells. For gross appearance see Fig. 5.

mass is larger than the ossified mass. This is a sign of sarcoma, unless there is a bursa over an exostosis.

But the most remarkable feature in this Case 2, is, first, in the x-ray (Fig. 4) there is no evidence of destruction of cortical bone, and the only change in the marrow shadow of the shaft could be explained by the cloudy effect produced by the shadow of the periosteal bone growth. When we look at the longitudinal section of the gross specimen in Figure 5, we see normal cortical bone under the tumor and a normal marrow. So far no tumor cells have been found in the shaft, but nevertheless I fear that there are some there. It is my opinion that it would have been a dangerous experiment to have chiselled off this periosteal growth and burned the cortical bone with the cautery, thus preserving the continuity of the humerus. Remember, this tumor was of at least two months' duration. It almost surrounds the shaft.

Periosteal sarcoma of this type has only been observed, in my series, in the past few years and in early cases. In one, the growth over the shaft

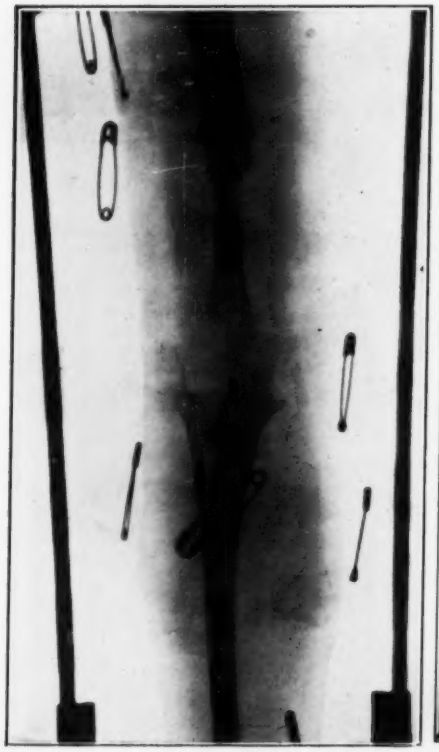


FIG. 7

CASE 2. Pathol. No. 36848. Bone transplant into defect after resection of lower end of humerus pictured in Fig. 4.

FIG. 8

CASE 3. Pathol. No. 30436. Benign ossifying periostitis and myositis which followed incision of an infectious myositis. At second operation periosteum of bone injured.

of the tibia was removed with the chisel and the cautery, and there has as yet been no recurrence, but the operator took a risk. In both of these cases the patients could have come to operation earlier, and perhaps, when we have the public better educated and our own experience and critical study improved, we may be able to select these very early periosteal sarcomas of the type illustrated in Figures 4 and 5, and perform a conservative resection with safety.

CASE 3. (Pathol. No. 30436.) Observed May 1922. *Final Diagnosis:* Benign ossifying periostitis with ossifying myositis. The history and the x-ray (Fig. 8) were sent to me by Dr. S. D. Foster of Toledo, Ohio.

The history is briefly as follows: The man, a painter aged thirty, injured his arm in February. In March, one month later, he sought Dr. Foster's advice for a swelling in the soft parts of the lower third of the arm. No x-ray was taken. An incision was made, and a small amount of pus evacuated. Three days later a further incision was made down to the bone. The wound healed. In May, two months later, the patient returned with a palpable hard tumor in the position of the former soft tumor, and the x-ray then taken is shown in Figure 8. Dr. Foster asked me whether it should be removed locally or whether there should be amputation.

In my reply I ventured the opinion that the x-ray and the history excluded sarcoma. Now, as I restudy it four years later and compare it with Figure 4, I would conclude that the history of finding pus at the first operation practically ruled out sarcoma. The x-ray shows a peculiar periosteal growth. The cortical bone and marrow are uninvolved. This could be explained by the trauma of the second operation in which the periosteum was injured while cutting through inflamed tissue. We know that when periosteum and muscle are injured an ossifying tumor may follow, but we do not know why it occurs in one patient and not in another. I have never observed pus in a sarcoma, nor sarcoma to follow the incision of an abscess. One would expect, therefore, in this case, that the history ruled out sarcoma. But from the x-ray sarcoma could not be excluded, especially when we compare it with Figure 4-*a*. Dr. Foster has reported this case, but unfortunately I cannot find the reference. I know the patient is well and bone formation has ceased. I was informed that the area was excised.

SCLEROSING SARCOMA AND SCLEROSING OSTEOMYELITIS

CASE 4. (Pathol. No. 37178.) (Figs. 9, 10, and 11.) Observed October 1925. *Final Diagnosis:* Sclerosing sarcoma of lower third of shaft of femur. Amputation, October 10, 1925. Ossifying metastasis to neck January 21, 1926, three months. Metastasis to the chest April 1926, six months. Death seven months after amputation, eleven months after onset.

I have selected this case of sclerosing sarcoma because it is typical in the x-ray, in the gross and microscopic appearances.

The typical dark band like a cloud around the shaft of the lower end of the femur with the faintest evidence of a narrow zone of periosteal bone formation and the irregular cloud effect below the dark band, between it

a *b*

FIG. 9

CASE 4. Pathol. No. 37178. Diffuse, sclerosing sarcoma. In *a* note the very faint zone of periosteal tumor and bone formation, while in *b* there is a large external, lateral, periosteal tumor with bone formation shown in gross in Fig. 10.

and the condyle (Fig. 9-*a*), is in favor of sclerosing sarcoma and against osteomyelitis. In Figure 9-*b* the ossification in the visible periosteal tumor is not as characteristic of sarcoma as in Figure 4-*b*. Now, if you will compare the x-rays *a* and *b* in Figure 9 with the longitudinal section of the gross specimen in Figure 10, you will see that the marrow cavity is filled with a dense growth where we have the shadow on the shaft in the x-ray. There is so much soft tumor tissue in the periosteal growth mixed with the bone formation that it gives the mottled shadow areas in Figure 9-*b*. Microscopically (Fig. 11), we have a typical sarcoma, which should be compared with Figure 6, sarcoma, Figure 3, inflammatory tissue in bone formation, and Figure 14, an inflammatory area in sclerosing osteomyelitis.

The x-ray in Figure 9 is sufficient to make a diagnosis of sclerosing sarcoma and to justify amputation without exploration.

Clinical Picture of Case 4. This girl was eighteen, and four months had passed since the initial pain, and precious time had been lost. Pain was intermittent in June; the mother, not the patient, remembers it. Pain was almost constant in July. Now, the patient admits swelling even in June, but she wanted to dance and, in spite of pain and swelling, she did dance in June and July. For thirteen days in August she walked, but did not dance, because it hurt too much. She could swim some. Then the knee became flexed, and then she took to crutches. In August, x-rays were taken, the diagnosis of sarcoma made, amputation advised but refused, and deep x-ray therapy was given. Because she was getting worse and because her parents still refused amputation, she came under my observation. Through no fault of her physician there had been this delay. Of course, an x-ray should have been taken in June.

When I saw her, there was fluid in the knee-joint and a palpable swelling at the lower end of the thigh,—typical sarcoma.

FIG. 10

CASE 4. Pathol. No. 37178. Sclerosing sarcoma. Large periosteal tumor to the left. Narrow periosteal tumor to the right. Marrow tissue replaced by bone and fibrous tissue filled with tumor cells. Cartilage and cancellous bone of condyle but slightly involved. For x-ray see Fig. 9.

Amputation gave some temporary relief. I cannot take up the rarity of ossifying metastasis to glands. This patient died of metastasis to the lungs, the common cause of death. Nor can I, in this paper, take up the broader question of the importance of educating our communities so that they will come at once for x-ray examination. I feel confident that many patients who have died of bone sarcoma in the past would be living today if they had had correct information about the importance of an immediate x-ray after the first pain, swelling, or loss of function in the region of any extremity.

According to my records in the surgical pathological laboratory of Johns Hopkins Hospital, the first sarcoma of bone to be cured by amputation occurred in 1913, so that when I reported two cases in 1920 it was about seven years after the operation. But now that the cases since 1916 up to 1921 have been observed more than five years, the per cent. of cures has

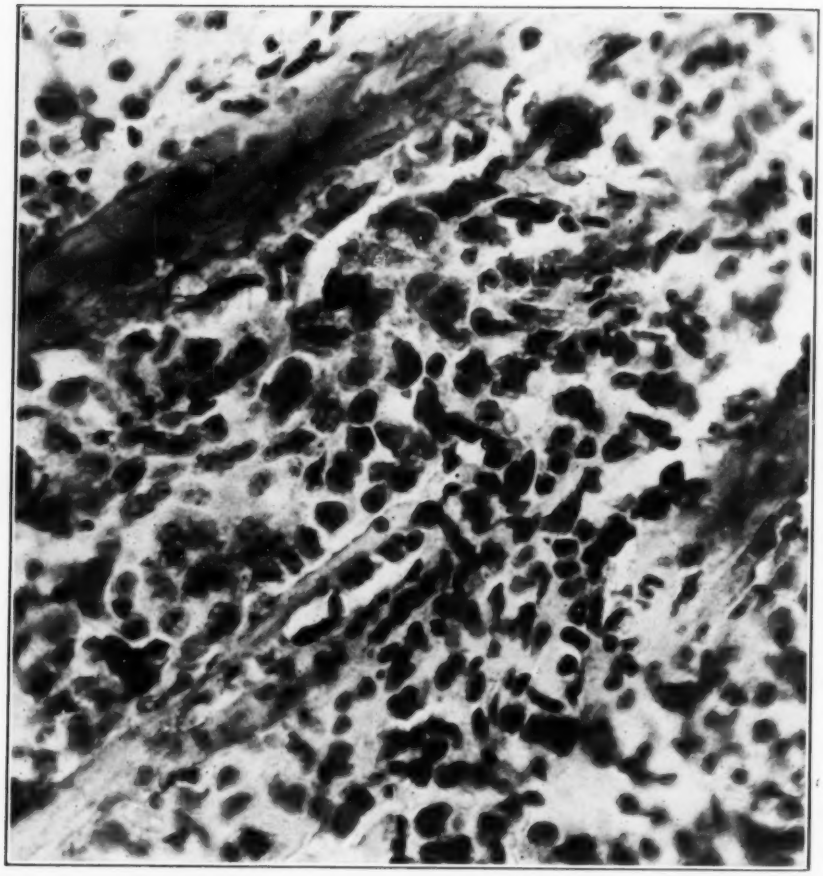


FIG. 11

CASE 4. Pathol. No. 37178. Osteogenic sarcoma; round and spindle cells; islands of bone undergoing destruction; no giant cells of epulis type. For gross appearance see Fig. 10, sclerosing sarcoma.

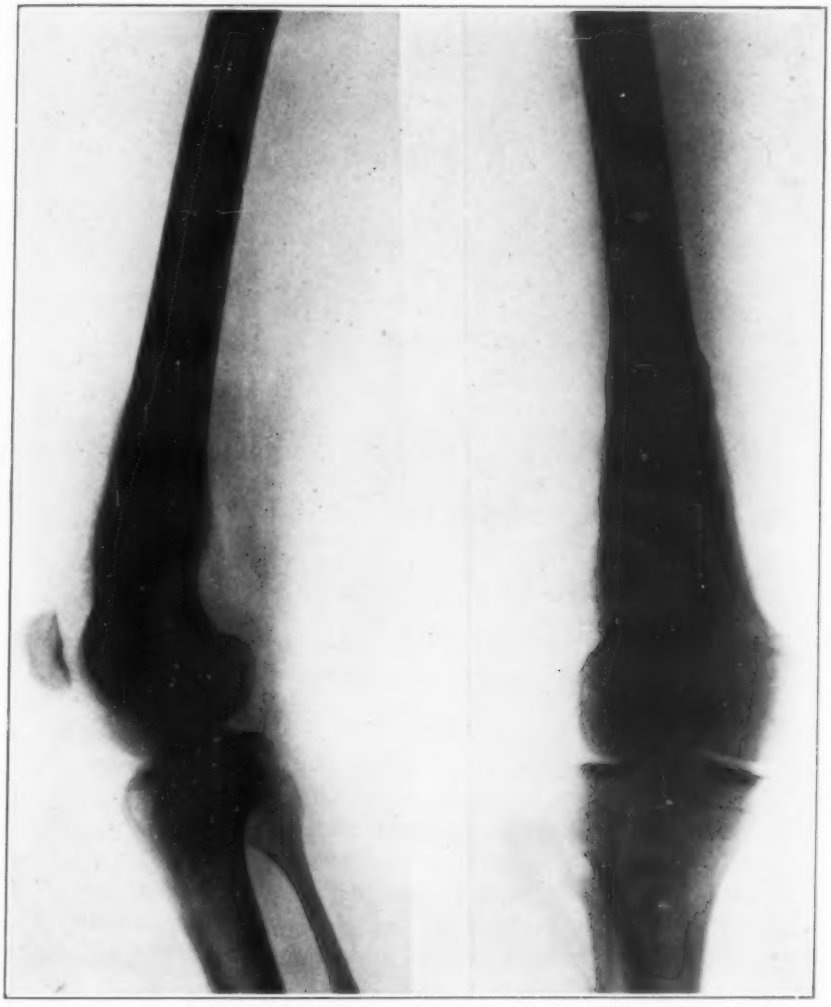
increased far out of proportion to the increase in the number of cases. All the cures are examples of sarcoma involving bone of the lower extremity below the upper third of the femur. There is but one explanation,—earlier intervention. In the past three years examples of sarcoma of bone of the upper extremity are coming under observation so much earlier that resection is possible, and I am reporting some of these cases in this paper.

CASE 5. (Pathol. No. 36784.) (Figs. 12, 13 and 14.) Observed June 1925. *Final Diagnosis:* Chronic sclerosing osteomyelitis of shaft of lower end of femur. Clinically and in the x-ray, doubtful. Exploratory operation June 1925. Frozen-section diagnosis: benign.

X-ray. In the lateral view (*a*) we have somewhat the picture of sclerosing sarcoma with bone formation in the periosteal tumor, but this new bone

does not throw the shadow typical of sarcoma. When we look at the anteroposterior view (*b*) the picture of sclerosing sarcoma is absent, for we see the marrow shadow. Compare this with Figure 9 where the dark cloud is present in both the lateral and the anteroposterior views. Practically all who examined the x-rays in this case (Fig. 12) were rather inclined to the diagnosis of sclerosing osteomyelitis. Nevertheless it was considered a doubtful case.

Palpation. I felt the irregular periosteal bone formation in this young



a *b*

FIG. 12

CASE 5. Pathol. No. 36784. Chronic sclerosing osteomyelitis. In *a*, like sclerosing sarcoma. In *b*, almost normal marrow shadow—against sclerosing sarcoma.

FIG. 13

CASE 5. Pathol. No. 36784. Low-power photomicrograph. Chronic sclerosing osteomyelitis. Bone, numerous osteoblasts; marrow replaced by cellular fibrous tissue, mid and right; very cellular left. For high-power photomicrograph see Fig. 14.

boy of seventeen on a number of occasions before operation. It felt like benign bone, similar to that in Case 1 (Fig. 1). It did not have the zone of soft tissue over the bone formation as in Cases 2, 3 or 4. On palpation it was almost as typically benign as Case 4 (Fig. 9) was typically malignant. Yet, the lateral view in the x-ray seemed to justify exploration.

Clinical Note. There was no definite history of a recent focus of infection and no sign of involvement of other bones. The boy's attention was called to the lower third of the femur by discomfort and a limp, and then the bony mass was felt. It came slowly and insidiously. There was nothing in the history to help us in the diagnosis.

Operation. July 1925. On exploring, all of the soft parts were normal. The new periosteal bone was covered with normal periosteum—the picture as described in Case 1 (Fig. 1). Frozen sections of periosteum and tissue outside of bone showed no evidence of inflammation or sarcoma. This

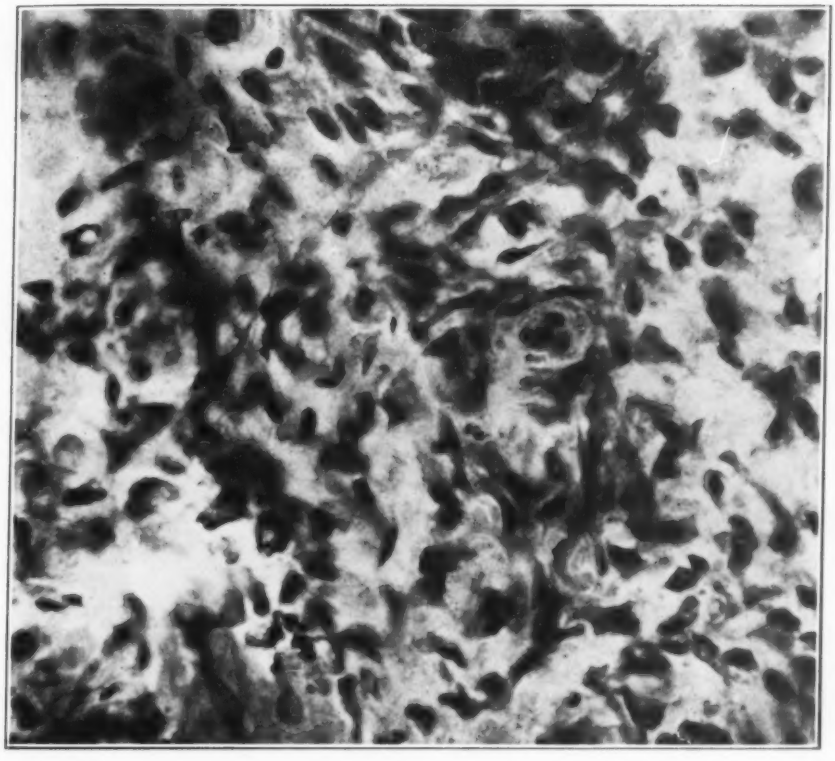


FIG. 14

CASE 5. Pathol. No. 36784. Chronic inflammatory tissue shown in high-power photomicrograph from an area in Fig. 13, to the left, in a case diagnosed chronic sclerosing osteomyelitis. See Fig. 12 for x-ray.

new periosteal bone chiselled like involucrum. In going through the cortical bone, there was no sequestrum. There was less fat and more fibrous tissue in the marrow, as we see in chronic osteomyelitis. There were, however, areas of normal marrow which I have never seen in sclerosing sarcoma. In the gross, therefore, the condition was benign. We must repeat here that if this were sarcoma, it would be of the sclerosing type as pictured in Figure 10 (Case 4). It would not be of the periosteal type as illustrated in Figure 4 (Case 2).

Frozen Section. I have already noted that the sections from the periosteal tissue outside of bone were negative. There was no soft tissue in the bone formation to allow a frozen section. We could pick out marrow tissue, and this was normal, perhaps a little more cellular. In the fibrous area in the marrow and in the cancellous bone the cellular picture resembled Figure 3 (Case 1). There were more plasma cells, as shown in Figure 14 and many more osteoblasts as shown in Figure 13. I was unable to see anything in the various frozen sections to justify the diagnosis of sarcoma. If it had been sarcoma, amputation would have been the operation of

choice, as, in our former experience, resection and bone transplantation, which would have been perfectly possible in this case, have not yielded a limb with as good function as the artificial limb. More than one-half of the cases have returned and asked for amputation.

Osteoblasts in Sarcoma. A very careful study of all the sections of sarcoma of bone associated with new bone formation, demonstrates that we may have new bone formation without the definite presence of osteoblasts, but osteoblasts may be found about the new bone formation in neoplasms just as they are found in traumatic and infectious ossification. The absence of osteoblasts is diagnostic of sarcoma, but their presence is not diagnostically significant of the benign lesion.

Result in Case 5. The patient was comfortable for six months. Then there was a recurrence of the pain, and the x-ray showed further bone formation on the outer side in the area which we had chiselled to expose the marrow cavity, but the cavity in the marrow was not yet ossified. Trauma or operation upon a benign ossification in muscle or periosteum may excite further growth of bone. So this pain and increase of swelling were not necessarily evidence of a mistaken diagnosis. It seemed unwise, as there was no leucocytosis, no fever, and no evidence of sequestration, to explore again. The only indications for exploration in osteomyelitis are the general signs of fever and leucocytosis, the local evidence of an abscess, or the x-ray picture of the sequestrum. Nothing was done, except to have the boy walk on crutches. The symptoms are now subsiding, and there is every evidence that no mistake in diagnosis has been made.

Chronic Sclerosing Osteomyelitis. Garré's contribution some years ago remained unnoticed generally for some time, but with the interest in bone sarcoma there have been more articles on this subject, and now it is always considered in the differential diagnosis and discussed in most contributions.

The relative frequency of sarcoma and chronic osteomyelitis has never been thoroughly worked out. In my own series the per cent. of osteomyelitis is on the increase. At the present time I think we see one case of osteomyelitis to twenty-five or thirty cases of sarcoma.

The word *non-suppurating* osteomyelitis as employed by Garré, and others since, should be given up. The study of my cases shows that in perhaps ten per cent. of cases there is later evidence of suppuration and sequestrum. I have now in preparation a second article on chronic sclerosing osteomyelitis, because when I made my first contribution some years ago I had not observed the late formation of abscess and sequestrum.

When cases of sarcoma of bone and osteomyelitis of the chronic sclerosing type delay months and longer before they come under observation for diagnosis and treatment, differentiation is not difficult. It is only in the past two or three years, coincident with the greater number of enlightened patients coming for examination after a very short period of warning, that we have encountered our diagnostic difficulties. The two cases (Cases 4 and 5) picture sufficiently—at least for an introduction—the sclerosing sarcoma and the sclerosing osteomyelitis.

CONCLUSIONS

I wrote my first paper on bone tumors about 1902, based upon all the cases we had observed in the surgical pathological laboratory since 1889 and the literature which I had reviewed in Progressive Medicine yearly since 1899. During these twenty-four years which have passed, I have gone over the bone material at least once a year in teaching, and, in writing many articles, I have critically restudied the material from every possible standpoint. A number of impressions are prominent in my mind from this continuous study:

First, just as we finished a restudy of all the material and formulated apparently definite conclusions for clinical and x-ray diagnosis, new cases came under observation at an earlier period which are exceptions to the rules. So, in writing this article, I felt I could teach more if I took a series of recent cases and described, in this group at least, the actual methods and difficulties of diagnosis.

When all bone lesions are x-rayed and studied within a few weeks after the first symptom, we may be able to evolve general diagnostic laws.

Second, the great value of the x-ray. One, to be a diagnostician of bone diseases, should constantly restudy the x-ray films or lantern slides, and these should be kept in very accessible filing-cases. One of the greatest obstacles to the majority of roentgenologists is that they are dependent for the final diagnosis in cases operated upon on a pathologist who may be neither interested nor expert in diagnosis. For example, the roentgenologist has been told again and again that the benign giant-cell tumor is a sarcoma. Naturally he concludes that central sarcoma is common. Even in the benign bone cyst, the fibrous tissue removed from the wall has been diagnosed sarcoma. Our x-rays of bone lesions, before they are valuable in the study of the diagnostic features, must be associated with a verification of the diagnosis not only by the microscope but by the final result. If the patient, whose femur is illustrated in Figure 12 (Case 5), lives, the diagnosis of osteomyelitis is verified. That Case 4 died with definite evidence of metastasis to the chest verifies the diagnosis of sarcoma. If Case 2 (Fig. 4) lives, we will never have a verification of the diagnosis of sarcoma unless the section is submitted to a committee of pathologists and my diagnosis of sarcoma confirmed. The present behavior of Case 1 (Fig. 1) strongly suggests that the diagnosis of a benign ossifying lesion is correct. There is no doubt in Case 3 (Fig. 8) that the diagnosis of benignancy is confirmed by the present condition of the patient.

Therefore, when we study x-rays, we learn most from those in which the diagnosis has been verified. It is dangerous to study x-ray films in which the ultimate condition of the patient is unknown, in which the pathology is relatively uncertain, and when the patients are living after amputation.

Third, the growing importance of the frozen section to help in the diagnosis at operation. The advice that should be most helpful to the pathologist

is that every pathologist who is called upon to make diagnoses from frozen sections during operation should practice daily on the fresh material with the polychrome-methylene blue stain of the frozen, unfixed tissue, and with the eosin-haemotoxylin stain of the tissue first fixed in formalin and then frozen. The majority of pathologists in this country connected with operating rooms are not frequently called upon by their surgical colleagues in the hospital for this frozen-section diagnosis, and they are not preparing themselves for this emergency. As the people in the different communities are becoming more enlightened and patients with bone and breast lesions are coming into the hospital quickly after the first symptoms, the diagnosis will rest more with the pathologist than with the roentgenologist.

Previous Literature. If one reading this article cares to compare it with the publications of previous studies, I would suggest the Journal of Radiology (I, 147–238) for March 1920, where I reported seventy cases of periosteal sarcoma and gave pictures of the various types.

In the Journal of Radiology (III, 310–317) for August 1922, I made my first report on the non-suppurating osteomyelitis of Garré, which I then called infectious ossifying periostitis. I hope the term *chronic sclerosing osteomyelitis* will finally be adopted.

I take this opportunity to make some additions and corrections to this article. Case 1, Pathol. No. 16865 (Fig. 1), the patient is living and well in 1926, confirming the diagnosis of a benign ossifying lesion.

Case 2, Pathol. No. 28771 (Fig. 6), in which we thought that the chronic sclerosing osteomyelitis was due to the gonococcus, the patient is still living in 1926, five years after the first observation, without symptoms.

Case 3, Pathol. No. 29084 (Fig. 8), diagnosed from the x-ray as a benign ossifying lesion of the upper end of the shaft of the femur, died after a hip-joint amputation. I have been unable to obtain the specimen to verify the operator's diagnosis of sarcoma.

All the other cases described there as infectious ossifying periostitis are living to verify the diagnosis, except Case 8 (Fig. 13), in which the disease was multiple and of the Paget type. After reporting this case (Pathol. No. 29831), I found metastatic carcinoma in the skull, the x-rays of which are pictured (Figs. 17 and 18). We knew that this patient's breast had been removed more than five years before, but the diagnosis had not been carcinoma. Dr. S. Ginsburg of New York, who followed this patient from the beginning to the end, has made a most complete report in the Archives of Surgery. In this instance a general disease of the skeleton of the Paget type of chronic sclerosing osteomyelitis or ossifying periostitis became secondarily involved with metastatic carcinoma.

The paper by Dr. S. Fosdick Jones appeared in the Journal of the American Medical Association (LXXVII, 986–990) September 24, 1921.

In the Journal of Radiology for February 1923 (IV, 46–51) I described the sclerosing type of osteogenic sarcoma. The case pictured in this contribution, in which the thigh was amputated after exploratory incision in

1922, lived in comfort for about two years and died of metastasis to the lung.

In the Journal of Radiology for April 1923 (IV, 119–127), I have grouped together, with illustrations, examples of benign and malignant ossifying periostitis and benign ossifying myositis. There are no corrections to this article. The diagnoses remain as given, verified by the present condition of the patients.

A LIGHT PORTABLE EXTENSION FRAME

BY WILLIAM ARTHUR CLARK, A.M., M.D., PASADENA, CALIFORNIA

Feeling the need of a simple extension frame which could be taken into a patient's home or to hospitals where a Hawley or Albee table is not available, the author designed the apparatus described below.

It weighs only twenty pounds and can be carried easily in one hand by taking off the extension rods and laying them parallel with one rod of the center piece. The support for the shoulders has been purposely omitted because a box or strong suit case with a blanket on it is available in any home or hospital.

It can be put on a fluoroscope table and is especially useful in this way for reduction of hips and femurs while under observation with the fluoroscope.

Upright supports were originally made to rest on the floor and support the foot pieces, but these were found unnecessary and are omitted from the pictures. The force of the extension from the perineal bars to the top of the foot piece resolves itself partly into a diagonal force from perineal bars to the bottom of the foot piece which tends to hold up the extension rod, leg and all.

Figure 1 shows the frame attached to an ordinary operating table with shoulder support obtainable in any operating room.

Figure 2 shows the detail of the center piece. It is made mostly of ordinary gas pipe. The long extension rods are of strong steel pipe of uniform thickness to allow the clamps of the foot pieces to be adjusted to

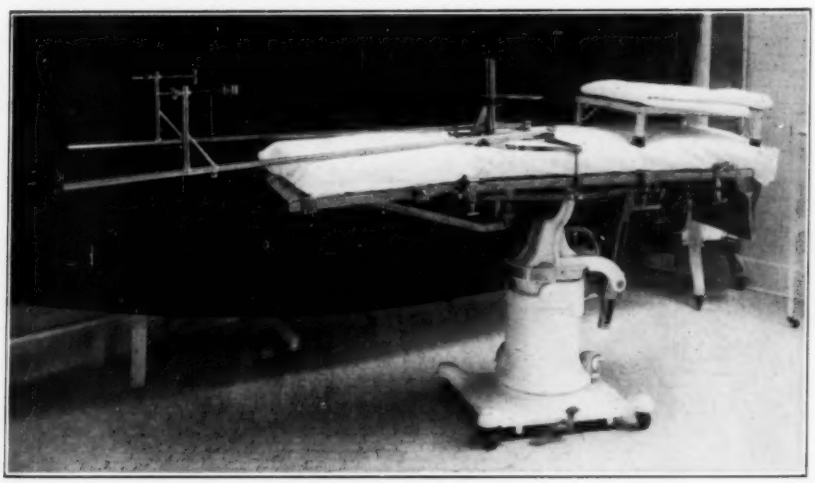


FIG. 1

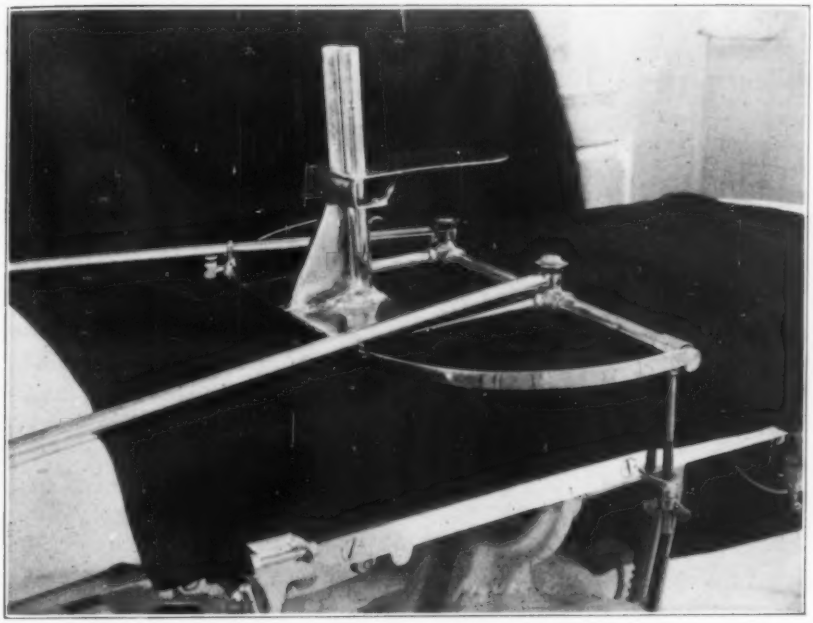


FIG. 2

any point on the rods. The upright perineal bars are one inch apart and the sacral support may be detached from them by merely lifting it off. The large nuts which hold the ends of the extension bars to the central frame can be put on and taken off by hand since they need not be screwed tight.

The clamps which hold the frame to the table are adjustable to the

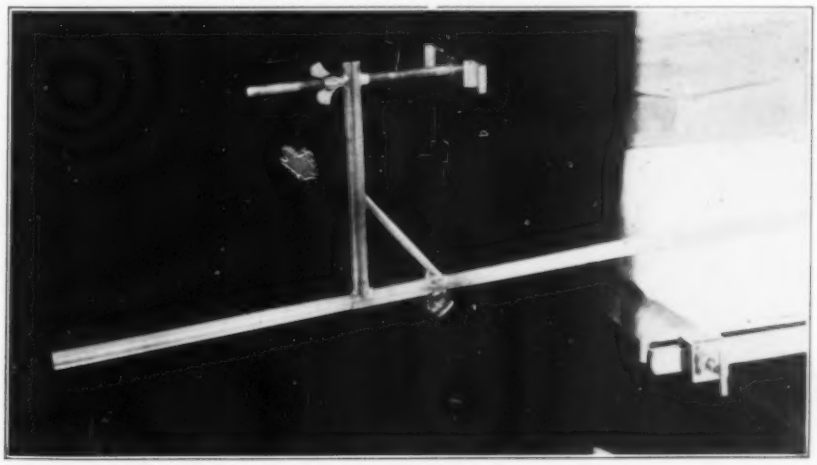


FIG. 3

width and thickness of the table top. A simple clamp holds the extension rod in abduction by means of a thumb screw. These clamps are not detachable from the half circle band so can not be lost off.

Figure 3 is a detail of the foot piece. This is made of strong steel piping, the base fitting closely around the extension rod and tightened to it by a thumb screw. The base piece is split longitudinally half its length to allow a reduction in its diameter by tightening the thumb screw, thus clamping the foot piece to the rod. The long threaded bolt at the top of the foot piece has a groove on its under surface the entire length which fits on a pin to prevent rotation of the foot. The foot is not tied up close to the foot bar, but enough space is left to allow putting on the plaster bandage. It is a good plan to put a well padded cast on foot and ankle and let it harden sufficiently to allow the extension straps to be applied around the cast before the operation or manipulation.

65 NORTH MADISON AVENUE,
PASADENA, CALIFORNIA

TRACTION IN DISEASES AND DEFORMITIES OF THE JOINTS

BY JOHN L. PORTER, M.D., CHICAGO, ILL.

After more than twenty years' experience the writer is convinced that simple weight and pulley traction is not accorded the value which it merits in the treatment of joint diseases and the correction of deformities. In evaluating the various procedures in use in joint diseases the writer has used the following order: Rest, Traction, Immobilization. The great value of traction lies in the fact that it is a means of securing rest and immobilization,—to a degree,—while at the same time securing muscular relaxation. Many unfamiliar with the use of traction have the idea it is intended to separate the joint surfaces, as it is used in fractures to separate bone fragments, but its sole value in the former is in securing relaxation of the persistent, involuntary muscular contraction which always accompanies painful or sensitive joints. Indeed, in fractures, separation of fragments only follows upon muscular relaxation. The reason for the infrequency of the use of traction the writer believes to lie in the lack of familiarity with the technique and lack of the (supposed) necessary appliances. The traction halter of leather illustrated in usual catalogs, with its numerous buckles and straps and rings, is not only unnecessary but actually undesirable, and the heavy iron spreader or cross-bar, usually illustrated with the halter, is worse than useless for making traction. To one unfamiliar with the quick and simple application of traction, it is astonishing how easily the desired end can be attained with a clothes-line, pulley, a piece of stiff wire,—say $\frac{3}{16}$ inch gauge,—some adhesive plaster, and a bandage. With that equipment and a pair of cutting pliers to cut and shape the wire spreader and perhaps a piece of board, on occasion, to make an inclined plane, traction can be applied in a very few minutes. The only requisite not included in the above list is the weight, and some one can be hunting for a brick or a flat-iron while one is putting on the traction.

HEAD TRACTION

In all painful affections of the spine except carcinoma, traction on the head with the patient recumbent is the most valuable measure for the relief of pain and muscular rigidity and spasm. The greatest trouble in making head traction usually lies with the halter. A very efficient halter can be made with muslin bandage for temporary use while a better one is being secured. A piece of bandage three inches wide is carried round the chin and the end held by an assistant above the head. Another piece of the same length is carried around the occiput and held in the same way. The two pieces are tied together with a short piece of bandage where they cross over the ears. The two ends are then tied together on each side,

FIG. 1

Author's method of head suspension with strips of muslin bandage.

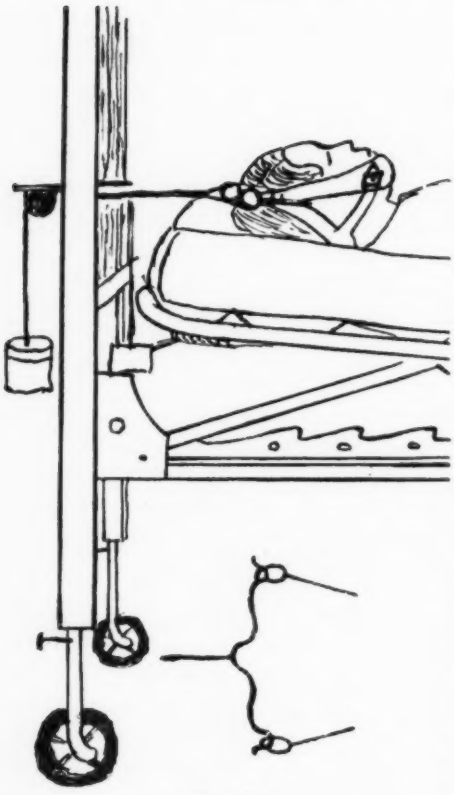


FIG. 2

Traction applied with permanent halter of aeroplane cloth.

making a loop to be hooked over the spreader (Fig. 1). The permanent halter is best made of canvas or some firm material which will wash, and the simpler it is, the better. The ones I use are made of aeroplane cloth with two sliding rings so that the pull on the chin and occiput automatically adjusts itself and it has only one buckle and strap, making it practically fool-proof (See Fig. 2). I say fool-proof because, if the halter is at all complicated, the nurse and the patient are continually fussing with it in an attempt to make it more comfortable, and I have frequently found them put on wrong side before. Having gotten the patient comfortably placed in bed and fitted with a halter, the next step is to place the pulley so that traction shall be in the long axis of the body. Much discomfort can be caused by having the pulley too high or too low. The amount of weight should depend upon the patient's comfort. It is better to begin with from five to eight pounds for a patient weighing one hundred fifty pounds and slowly increase it until the patient decides he has just enough.

The head of the bed must be lifted from six to eight inches to prevent the patient sliding upward. Whether or not the patient shall be allowed a pillow, and if so, the size of the pillow, will depend upon the nature and location of the trouble and the rigidity of the spine. Until relaxation has been secured, it is often best to let the patient lie flat on the mattress with no pillow or other support. After the muscles have relaxed, an attempt should be made to restore the normal contour of the spine, and this is best done by putting a small, rather firm pillow under the head and a pad made of folded woolen blanket under the lumbar spine. Aside from diseases of the spine, most injuries such as dislocation of the cervical vertebra and spinal fractures are most quickly relieved by traction thus applied.

LEG TRACTION

Traction on the leg for painful conditions about the knee and hip is usually best applied by the method commonly known as Buck's extension, the weight being attached to the leg by strips of adhesive plaster applied on each side. There are a number of features, however, which make for comfort and efficiency which should be observed. While the ordinary light-weight zinc oxide adhesive is ordinarily used, it is not nearly as satisfactory as a heavy rubber plaster spread on moleskin, and best of all is a heavy diachylon plaster also spread on moleskin which contains no rubber at all. A strip of adhesive from three to four inches wide at one end, tapering to two inches at the other end, and a little longer than the leg, should be applied smoothly on each side of the leg from the level of the perineum to a point just above the malleoli. These should be held by an assistant at one end while the operator holds the other ends and gently rubs and smooths the adhesive, as there must be no wrinkles. These two traction strips should be fastened to the leg by long, narrow strips of common adhesive, running around the leg diagonally but never passing over the patella. A narrow strip of felt or two or three layers of bandage or a band of sheet-wadding should surround the leg just above the malleoli. Then the leg is smoothly bandaged from the malleoli to the groin. If the bandage is fastened with a basting stitch running the entire length of the leg on each side immediately after it is applied, it will stay in place. Otherwise it will slip down and have to be renewed every day or two. A spreader consists of a piece of wood about six inches long by one-fourth inch by one and one-half inches wide, with a hole in the center. It is then fastened to the loose ends of the adhesive plaster below the foot to prevent the plaster

FIG. 3

Simple form of leg traction with moleskin adhesive plaster.

FIG. 4

Leg traction applied. Two types of pulley arrangement are shown.

from making pressure on the malleoli or adhering to the edges of the foot. Through the hole in the spreader a cord is fastened and carried over a pulley at the bottom of the bed (See Figs. 3 and 4). A roll of some resilient material (old pieces of flannel blanket are best) thick enough to keep the heel from touching the bed is placed beneath the tendon Achilles. Sometimes it is also necessary to put a small pad under the knee temporarily to prevent the pain caused by immediate hyperextension. In all cases where there is flexion deformity at the hip the angle of flexion should be accommodated by putting the leg on an inclined plane and gradually lowering the incline as pain and spasm disappear. The inclined plane must be solid. A board of proper width padded with a folded sheet on one side is best. Pillows, blankets, etc., built up to resemble an inclined plane, are never satisfactory. They soon get out of place and leave the patient

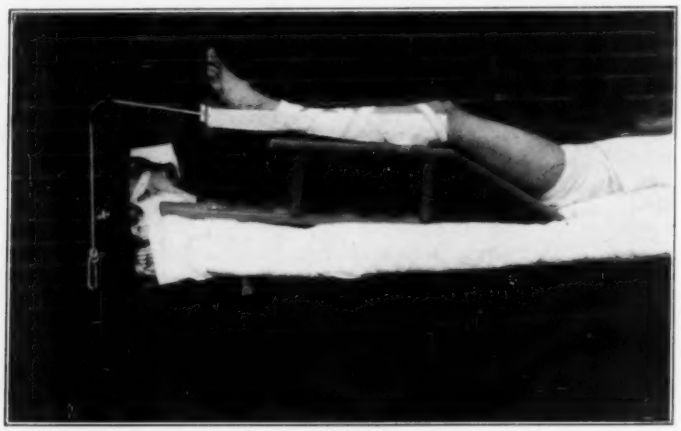


FIG. 5

Leg traction on inclined plane in flexion deformities of knee.

uncomfortable. As the inclined plane is lowered, the pulley must be lowered also to maintain the traction in the long axis of the leg.

KNEE TRACTION

Traction for pain and spasm and flexion at the knee is applied the same as for traction at the hip except the adhesive is only carried up to the upper end of the tibia. Traction must be made in the long axis of the tibia, so in all conditions where there is any flexion at the joint the whole leg must be elevated so that the tibia is horizontal. Then the leg can be slowly lowered as the stiffness and spasm disappear. Figure 5 shows a very simple and satisfactory support for knee traction made of pieces of ¾ inch planed board and hinged so that it can be gradually lowered by carrying the uprights forward to the cleats nailed on the base.

ARM TRACTION

Traction is used on the arm to secure extension or abduction or both. Traction for injuries or diseases of the shoulder is best made with the forearm semiflexed and resting on an incline. Then traction can be made in the long axis of the humerus by means of adhesive plaster from the shoulder to the elbow with the pulley fixed at the side of the bed (Fig. 6); or abduc-

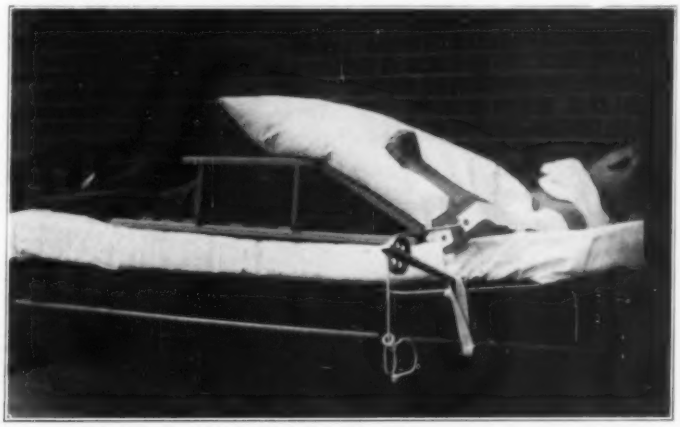


FIG. 6
Traction in diseases or injuries of shoulder.

tion can be secured by traction with a spreader and folded towel instead of adhesive, the pulley being at the head of the bed. The two methods can be advantageously combined in cases with severe pain or spasm.

Traction on the forearm for trouble at the elbow is rarely used, as, in practically all diseases and injuries of the elbow except fractured olecranon, flexion is desirable and treatment or immobilization can best be carried out in that position.

COMPARATIVE STUDIES BETWEEN SYNOVIAL FLUID AND PLASMA*†

Preliminary Report

BY NATHANIEL ALLISON, M.D., FRANK FREMONT-SMITH, M.D.,**
MARY ELIZABETH DAILEY, A.B., MARGARET A. KENNARD, A.B., BOSTON

Knowledge of physiology of the synovial membrane is in about the same state today as it was in 1859 when Claude Bernard said that little was known either of its anatomy or physiology. Realizing the advance which has followed an analytic study of the cerebro-spinal fluid and the not unusual availability of synovial fluid, the authors of this preliminary study have set as their purpose an analysis and tabulation of the joint fluids secured in routine examinations of injured and diseased joints. The study was first undertaken in September of 1925 and has since been carried on as part of routine examinations in joint lesions.

During the past six months we have made comparative studies between synovial fluid and plasma in thirty-five instances. The material was obtained from a wide variety of cases. In the twenty-three knee-joint fluids which form the basis for this preliminary report, the diagnosis has been established. We have divided these into three groups:

First: non-infected fluids, including chronic arthritis of various types, post-traumatic effusions, etc., (17 fluids);

Second: fluids infected with pus-forming organisms: streptococcus and gonococcus, (4 fluids);

Third: fluids from tuberculous joints, (2 fluids).

In addition to bacteriological studies, animal inoculation, smear and cell count, we have studied the distribution between plasma and synovial fluid of sugar, non-protein nitrogen, chloride and protein. (In one case not reported here in detail, a strongly positive Wassermann reaction was present in both the serum and the synovial fluid.)

Since all of these fluids are from pathological cases, our results may have little bearing upon the normal physiology of synovial fluids.

We have approached this investigation with two questions in mind: First, what physico-chemical laws determine the composition of such synovial fluids? Second, what diagnostic value has the chemical examination of joint fluids?

*From the Orthopaedic Service and Neurological Laboratory, Massachusetts General Hospital, and the Departments of Neuropathology and Orthopaedic Surgery of the Harvard Medical School. This work forms part of a comparative study between plasma and various body fluids which has been carried on in the Neurological Laboratory of the Massachusetts General Hospital for the past two years, (aided in part by a grant from the Ella Sachs Plotz Foundation).

**John White Brown Scholar.

†Read before the American Orthopaedic Association at Atlanta, April 27, 1926.

Perhaps the most interesting results of this investigation have been the close analogies found between these synovial effusions and such body fluids as pleural effusions, peritoneal effusions, and cerebro-spinal fluid. These analogies have both theoretical interest and diagnostic significance.

METHODS

Blood samples were taken either immediately before or immediately after aspiration of the joint. The following technique was used to avoid the loss of carbon dioxide to the atmosphere which would tend to give too high plasma chloride values. Venous blood was collected with little or no stasis into a dry glass syringe containing just sufficient powdered potassium oxalate to prevent clotting. It was then transferred to centrifuge tubes under a layer of mineral oil. A rubber stopper with central hole was then inserted into the centrifuge tube until only a thin film of oil remained between the bottom of the stopper and the surface of the blood, the excess oil escaping through the hole in the stopper. This hole was then plugged with a short glass rod. Immediately after centrifuging, the plasma was separated from the packed red cells and determinations were carried on without delay.

The sugar was determined by the method of Folin and Wu,[1] using 2 cc. of plasma or synovial fluid, the final dilutions being made in the modified sugar tubes recommended by Rothberg and Evans.[2]

The non-protein nitrogen was determined by the method of Folin and Wu,[3] using 2 cc. of plasma or fluid.

The chloride was determined by the method of Van Slyke,[4] using 3 cc.

The total protein was calculated from the total nitrogen, which was determined by the Dyer[5] modification of the macro-Kjeldahl method, using 5 cc. of plasma or fluid.

Total nitrogen subtracted from non-protein nitrogen leaves protein nitrogen which, when multiplied by the factor 6.25, gives protein.

In *Table 1* will be seen the non-infected synovial fluids from ten fasting patients compared to the plasma. The non-protein nitrogen is found to be approximately equally distributed, while sugar is nearly always a little lower in the joint fluid than in the plasma. The most constant difference from plasma is found in the protein and chloride. The protein in the joint fluid we have found to be always lower than in the plasma, while the chloride is always higher than the plasma chloride. It is interesting that this same inverse relationship between chloride and protein holds true for peritoneal effusions, pleural effusions, cerebro-spinal fluid, and the aqueous and vitreous humors of the eye; in fact, it may be stated as a general rule that those body fluids which are the product of dialysis from the plasma contain less protein and more chloride than the plasma.

Van Slyke, Wu and McLean[6] have shown that the law of the Donnan Membrane Equilibrium plays an important rôle in the distribution of the chloride ion between plasma and red blood cells. Their recalculation of

TABLE 1

NON-INFECTED SYNOVIAL FLUIDS FROM FASTING PATIENTS

Case No.	Initials	Hosp. No.	N.P.N. mgm/100 cc. Plasma	N.P.N. mgm/100 cc. Fluid	SUGAR mgm/100 cc. Plasma	SUGAR mgm/100 cc. Fluid	PROTEIN gm/100 cc. Plasma	PROTEIN gm/100 cc. Fluid	CHLORIDE (as NaCl) mgm/100 cc. Plasma	CHLORIDE (as NaCl) mgm/100 cc. Fluid
1	M.G.	273026	22	19	98	89	7.58	5.19	606	627
2	O.A.	254161	23	25	88	82	7.54	6.33	562	584
3	F.C.	572511	28	29	102	103	6.89	3.64	585	617
4	W.C.	268927	30	29	105	101	6.97	3.88	589	620
5	W.P.	271558	26	23	89	72	7.01	5.94	584	593
6	E.D.	274134	26	25	118	81	8.25	5.51	562	587
7	W.L.	274858	26	23	90	79	8.93	5.60	584	674
8	J.A.	275472	19	22	90	88	8.01	5.97	573	598
9	J.A.	275472	..	..	90	86	....	....	558	587
10	H.C.	274111	..	..	94	58*	....	....	...	...

*We have no explanation for this low value in a non-infected fluid.

the data of Loeb, Atchley and Palmer[7] indicates that the same law is significant in the equilibrium between plasma and pleural or peritoneal fluids.

Using the equation derived by Van Slyke, Wu and McLean, we have found that the Donnan Membrane Equilibrium applies to the distribution of protein and chloride between plasma and these non-infected pathological synovial fluids as satisfactorily as it does to the data of Loeb, Atchley and Palmer. The details of these calculations will be reported elsewhere.

TABLE 2

NON-INFECTED SYNOVIAL FLUIDS REMOVED DURING ANAESTHESIA
(ether, gas-oxygen or ethylene)

Case No.	Initials	Hosp. No.	N.P.N. mgm/100 cc. Plasma	N.P.N. mgm/100 cc. Fluid	SUGAR mgm/100 cc. Plasma	SUGAR mgm/100 cc. Fluid	PROTEIN gm/100 cc. Plasma	PROTEIN gm/100 cc. Fluid	CHLORIDE (as NaCl) mgm/100 cc. Plasma	CHLORIDE (as NaCl) mgm/100 cc. Fluid
11	E.L.	274737	27	29	116	96	7.59	5.41	608	628
12	G.L.	275385	31	31	153	89	7.52	4.58	570	593
13	G.S.	274773	25	22	121	110	6.84	4.43	600	620
14	R.R.	274498	20	21	130	99	7.51	5.67	615	636
15	E.M.	275148	..	..	...	114	....	....	...	592
16	M.B.	273410	26	34	209	116	....	....	...	...
17	B.—	P.H.	21	24	91*	101	....	3.70	600	630

*Blood taken before ether.

AVERAGE VALUES

	SUGAR mgm/100 cc. Plasma	SUGAR mgm/100 cc. Synovial Fluid
10 fasting non-infected fluids	96	84
7 fluids removed during anaesthesia	146	104

This indicates that a simple membrane equilibrium exists between plasma and these synovial fluids, and that such pathological synovial effusions are derived from the plasma by dialysis rather than by secretion. It should be emphasized, however, that such conclusions do not necessarily apply to the normal synovial fluid.

Table 2 shows the sugar content of plasma and non-infected synovial fluid found during anaesthesia (ether, gas-oxygen, or ethylene) in seven instances. It will be seen that the anaesthesia has resulted in a rise both in plasma and in synovial fluid sugar levels well above the average values of the unanaesthetized cases. This indicates that a rise in blood sugar is accompanied by a rise in synovial fluid sugar, and is confirmatory of the striking results obtained by Cajori, Crouter and Pemberton.[8] In Case No. 17 the plasma was taken fasting before anaesthesia, the fluid during anaesthesia,—which explains why the fluid sugar is higher than that in the plasma.

Table 3 shows the chloride content of plasma and synovial fluid in twenty-one cases, arranged in order of descending plasma chloride values. It will be seen that the synovial fluid chloride is always higher than that of

TABLE 3

CHLORIDE IN PLASMA AND SYNOVIAL FLUID

Arranged in order of Descending Plasma Chloride Values

	CHLORIDE (as NaCl) mgm/100 cc.	
Case No.	*Plasma*	*Synovial Fluid*
14	615	636
11	608	628
1	606	627
13	600	620
17	600	630
18	598	612 (not included elsewhere)
4	589	620
3	585	617
5	584	593
7	584	674
8	573	598
12	570	593
21	565	575
6	562	587
2	562	584
9	558	587
20	553	577
19	530	556
25 *	503	531
26	499	533
27	499	529

*The cause of the prolonged septic temperature and multiple arthritis in this patient could not be determined. The data is included because of the unusually low chloride values.

the coincident plasma, and that variations in the level of plasma chloride are accompanied by similar variations in synovial fluid chloride. This equilibrium is influenced by the difference in protein content of plasma and synovial fluid, and will be discussed in more detail in a separate communication.

In *Table 4* we have compared the average fasting sugar content of ten non-infected synovial fluids with the average value of four fluids infected with streptococcus or gonococcus, and with two fluids from proved tuberculous joints. These cases are far too few to allow conclusions; nevertheless it is interesting that in these cases the sugar content of the synovial fluid is definitely lowered just as it is in the spinal fluid in cases of meningitis, and as in meningitis the tuberculous fluids may show less reduction of sugar than the acute purulent fluids.[9] It is worth noting that these low sugar values are not dependent upon low plasma sugar, for the plasma sugar is normal or elevated in these cases. The low sugar is due, we believe, to a local breakdown of glucose by the bacteria present in the fluid; with the production of lactic acid or other organic acids. This mechanism is believed to be the cause of the low sugar and increased lactic acid content of

TABLE 4

BACTERIALLY INFECTED SYNOVIAL FLUIDS

Streptococcus or Gonococcus

Case No.	Initials	Hosp. No.	*N.P.N.* mgm/100 cc. Plasma	N.P.N. Fluid	*SUGAR* mgm/100 cc. Plasma	SUGAR Fluid	*PROTEIN* gm/100 cc. Plasma	PROTEIN Fluid	*CHLORIDE (as NaCl)* mgm/100 cc. Plasma	CHLORIDE Fluid
19	R.H.	269906	25	24	118	19	5.98	3.56	530	556
20	M.M.	273890	22	23	96	37	8.67	6.39	553	577
21	L.M.	273733	27	27	91	43	8.38	6.92	565	575
22	W.V.	274180	..	..	...	25	....	....	...	...

TUBERCULOUS SYNOVIAL FLUIDS

(proved by biopsy or guinea-pig inoculation)

Case No.	Initials	Hosp. No.	*SUGAR* mgm/100 cc. Plasma	SUGAR Synovial Fluid
23	M.M.	592224	78	45
24	G.D.	275495	93	61

AVERAGE VALUES

	SUGAR mgm/100 cc. Plasma	SUGAR Synovial Fluid
Fasting non-infected (10 fluids)	96	84
Streptococcus or gonococcus (4 fluids)	102	31
Tuberculous (2 fluids)	86	53

the cerebro-spinal fluid in acute meningitis,[10] and would explain the increased acidity of infected synovial fluids found by Boots and Cullen.[11]

Should a much larger series of cases consistently show this low sugar in the infected synovial fluids, we believe that the sugar determination would become a valuable diagnostic aid, particularly as bacteriological studies may take seventy-two hours or more for completion, and guinea-pig inoculation several weeks. A sugar determination may be completed in twenty minutes, and can be performed by any laboratory which is prepared to do blood sugars.

It is interesting that the lowest chloride values in our cases are found in the infected fluids, and that these low chloride values are associated with low plasma chloride. This is also the case in spinal fluid and plasma in meningitis.[9] We believe that, as in meningitis, these low chloride values are largely dependent on the low plasma chloride which accompanies fever rather than upon the local condition in the joint.

SUMMARY

1. Protein, chloride, sugar and non-protein nitrogen have been determined in plasma and pathological synovial fluids in twenty-three instances.

2. The protein content of the synovial fluids is less than that of the plasma. The chloride content is greater than that of the plasma. This inverse relationship of protein and chloride is analagous to that found between plasma and peritoneal effusions, pleural effusions, and the cerebro-spinal fluid, and is probably influenced by the Donnan Membrane Equilibrium.

3. Low plasma chloride is accompanied by low chloride in the synovial fluid.

4. The non-protein nitrogen is approximately equally distributed between plasma and synovial fluid.

5. In fasting patients, the sugar content of non-infected synovial fluid is usually slightly lower than that of the plasma.

6. The hyperglycemia caused by anaesthesia is accompanied by a rise in sugar content of the synovial fluid.

7. In four instances of bacterially infected fluids the sugar content was markedly lowered, while in two cases of tuberculosis of the joint the sugar content was moderately lowered. This is analagous to the low sugar content of the cerebro-spinal fluid in purulent and tuberculous meningitis.

8. It is suggested that determination of the sugar content of synovial fluids may prove to be of diagnostic value.

BIBLIOGRAPHY

1. Folin, O., and Wu, H.: J. Biol. Chem., XLI, 367, 1920.
2. Rothberg, V. E., and Evans, F. A.: J. Biol. Chem., LVIII, 435 and 443, 1923–4.
3. Folin, O., and Wu, H.: J. Biol. Chem., XXXVIII, 87, 1919.
4. Van Slyke, D. D.: J. Biol. Chem., LVIII, 523, 1923–4.
5. Dyer: J. Chem. Soc., LXVII, 811, 1895.

6. Van Slyke, D. D., Wu, H., and McLean, F. C.: J. Biol. Chem., LVI, 765, 1923.
7. Loeb, R. F., Atchley, D. W., and Palmer, W. W.: J. Gen. Physiol., IV, 591, 1921–2.
8. Cajori, F. A., Crouter, C. Y., and Pemberton, R.: Arch. Int. Med., XXXVII, 92, 1926.
9. Fremont-Smith, F., and Dailey, M. E.: Arch. Neurol. and Psychiat., XIV, 390 and 509, 1925.
10. Greenfield, J. G., and Carmichael, E. A.: The Cerebro-spinal Fluid in Clinical Diagnosis. Macmillan & Co., London, 1925.
11. Boots, R. H., and Cullen, G. E.: J. Exper. Med., XXXVI, 405, 1922.

DISCUSSION

Note: The paper of Dr. Key to which reference is made in this discussion appeared in the *Journal* of July 1926.—*Editor.*

Dr. Robert B. Osgood, Boston, Mass.: I am interested in this as a new method of diagnosis. As far as I know, there has never been an attempt before to obtain from synovial fluid information which would lead to an earlier conception of the type of joint infection or joint pathologic condition that we are dealing with. I congratulate Dr. Allison very much on this paper.

Dr. Key's paper is getting at very fundamental things. His work seems to show that infection is rarely long confined within the synovial cavity. In five days, perhaps earlier than that, in these joints the deeper tissues became involved.

I think these are papers that ought to give us many new thoughts as to the types of infection and the paths by which infection may travel.

Dr. Leo Mayer, New York, N. Y.: As one who frankly admits very great ignorance of the physiological process in joints, I welcome these two papers. There has been surprisingly little written on the exact physiology of the joint. I do not refer to the mechanics of joints, but to the chemistry of the synovial fluid and the microscopic processes going on in joints.

Dr. Key stated that in the normal wear and tear of the joint we must think of constant small particles being worn off and discharged into the joint and that there must be some way in which these particles are removed. Has anyone ever shown that there is such wear and tear and found miscroscopic evidence of this? This is a primary ABC question of the physiology of joints which I do not believe anyone thus far has attempted to answer. It is the same when we think of bone growth. We are constantly doing complicated experiments on bone transplantation, but I for one do not yet know how a normal bone cell lives. Though I have looked into the literature, I have not found anyone who has done research that will illuminate us on the length of time a bone cell lives. The same may be applied to the joint cell.

Dr. Key's paper was very interesting and it is hard for me to digest it in a short time. Each phase of his work will require careful scrutiny to find out what it signifies. I was especially struck by the fact that the particles penetrated into the bone marrow and that the periosteum seemed to act as a definite limiting membrane. It is evident that they got in through some of the penetrating canals or through some of the blood vessels. Finally, that the cartilage of the joint also acts as a sort of limiting membrane. The full significance of this paper I do not think can be estimated at all. I should like to make the suggestion that, when a man is doing a piece of work of this kind, he communicate with the other members of the Association who are also interested and that he forward his microscopic slides for study and in that way stimulate others to do this work and also receive help for himself in the final interpretation of his own work.

Dr. J. Albert Key, St. Louis, Mo. (closing): In answer to Dr. Mayer's question as to the evidence of wear and tear of joints, we see very little of it in the smaller laboratory animals, but Hammar, in the Archiv f. Mik. Anatomie, 1894, noted fragments of the joint surface in the synovial fluid, and Meyer at Stanford has recently published

observations on dissection material in which there was considerable evidence of attrition in the larger joints of old men.

What I wish to emphasize is that solid particles and coarse colloids do not pass through the joint lining in their free state, but are, for the most part, carried out of the joint by living cells. This is not true of true solutions or fine colloids. I have some joints injected with trypon blue and Prussian blue. In these joints the material passed out through the synovial membrane in all directions and also diffused into the cartilage.

AVULSION OF THE LESSER TROCHANTER*

BY S. A. SCHLUETER, M.D., CLEVELAND, OHIO

Strong muscular contractions not uncommonly produce fractures of bone. An avulsion of the lesser trochanter of the femur belongs to this class and because of the rarity of this lesion, the following case is reported.

G. B., aged 14, a colored schoolboy, entered Lakeside Hospital, April 20, 1925, complaining of pain in the left hip. During a game of baseball, the patient had stopped abruptly at second base, and, while attempting to keep his body upright, experienced a sudden severe pain in the left hip which forced him to lie down. Although the injured leg would support the weight of the body, walking was very painful and he had to be carried from the field. He was brought directly to the hospital accident ward. The left thigh was held in ninety degree flexion and any attempt to straighten out the limb produced pain and muscle spasm. Other passive movements of the hip, however, could be performed if carried out slowly and carefully. There was no swelling, but a definite point of tenderness could be elicited when pressure was applied over the lesser trochanter. A determination of the muscular power about the hip was unsatisfactory because of the pain which active movements produced. The abductors were strong but the adductors seemed weakened. Inability to flex the thigh and the associated pain of attempted extension were the outstanding symptoms. General examination was otherwise normal. A roentgenogram of the hip showed an avulsion of the lesser trochanter (Fig. 1). After two days the pain produced on extension of the limb had diminished to such an extent that the patient was able to hold the leg in the extended position without discomfort. There was still some tenderness over the lesser trochanter. Flexion of the hip could not be carried out beyond the forty-five degree angle. The power of adduction remained weakened. Three days following the injury a plaster hip spica cast was applied with the hip fixed in forty-five degree flexion and slight adduction. Several days later the patient was discharged from the hospital and subsequently observed in the dispensary. The cast was removed after seven weeks. One month later the patient had full return of function in the injured limb.

Ruhl [1] was the first to make an exhaustive search in the literature of such cases. Including one case reported by himself twenty-two cases were compiled. More recently Moreau and Lecouturier [2] revised the reported series of Ruhl and discounted three cases with multiple fractures of the same femur. They were able to collect other cases from the literature and including a personally observed case brought the total number to thirty-three. Eikenbary [3] reported three cases, but only one was placed in the list compiled by Moreau and Lecouturier. The other two must be considered questionable because both were examined after a relatively long period of time had elapsed from the date of injury and the x-ray evidence was not conclusive. Langdon[4] has reported an additional case and Heath,[5] Pugh [6] and Carl[7] have since each reported one case. Recently Balensweig [8] reported five cases. The case referred to in this article, therefore, brings the total number of cases reported to forty-three.

*From the Department of Surgery, the Lakeside Hospital and the Western Reserve University School of Medicine.

FIG. 1

Roentgenogram of upper femora showing a complete severance of the lesser trochanter of the left femur. There is a marked displacement upwards of the fragment of bone.

Etiology. The greatest number of these fractures occur in young people before the epiphysis of the lesser trochanter has fused with the femoral shaft, — the lesion being an epiphyseal separation. A few cases have been reported occurring in elderly individuals, probably the result of an abnormally strong pull of the psoas muscle on the lesser trochanter whose trabecular structure is weakened by rarefaction. The mechanism undoubtedly consists in a tearing off of the lesser trochanter when an effort is made by the psoas muscle to prevent the body trunk from falling forward or backward. This is illustrated in the case reported above. With the leg fixed, an attempt was made to maintain equilibrium in the upright position by such violent psoas contraction that an avulsion and an epiphyseal separation of the attached trochanter resulted.

Symptomatology. Among the recorded cases, pain in the affected hip and tenderness over the lesser trochanter are constant features. Swelling in the upper inner thigh may or may not be visible. The patients can usually be made to support the weight of the body on the injured limb. The inability to bring the leg forward and the associated pain may, however, so seriously interfere that walking is either impossible or accomplished with difficulty. Passive movements are not interfered with; active movements are restricted, especially extension, because of pain. Inability to flex the hip when in the sitting position, considered by Ludloff [9] diagnostic of the loss of psoas power, and known as Ludloff's sign is pathognomonic of a complete severence of the lesser trochanter providing all the fibres of the psoas muscle are likewise torn. It is conceivable, however, that some degree of flexion is possible if some periosteal attachments of the trochanter remain intact or if the fibres of insertion of the iliacus muscle prevent a great displacement of the trochanter.

Diagnosis. The lesion can easily be recognized by (1) the nature of the injury, (2) a localized point of tenderness over the lesser trochanter,

(3) the inability to flex the hip while in the sitting position, (4) the absence of shortening of the affected limb and (5) the x-ray evidence of a misplaced lesser trochanter.

Good functional results have been attained in all the recorded cases by merely immobilizing the limb. The best results are obtained by fixing the hip in a forty-five to sixty degree position of flexion with a hip spica plaster cast. No interference with function of the psoas muscle will occur if a fibrous instead of a bony union results.

REFERENCES

1. Ruhl, E.: Ueber isolierten Abriss des Trochanter minor. Beitr. z. klin. Chir., CXVIII, 676–695, 1920.
2. Moreau, J. and Lecouturier: Fracture Isolée du Petit Trochanter. Arch. franco-belges de chir., XXVI, 1121, 1923.
3. Eikenbary, C. F.: Avulsion or Fracture of the Lesser Trochanter. J. Orthrop. Surg., III, 464–468, 1921.
4. Langdon, J. F.: Traction Fracture of the Lesser Trochanter. Nebraska State Med. J., IX, 181, 1924.
5. Heath, P. M.: Traction Fracture of the Small Trochanter. Proc. Roy. Soc. Med., XVI, Part 3, Sect. Orthop. p. 12, 1923.
6. Pugh, W. T. G.: Fracture of the Small Trochanter. Proc. Roy. Soc. Med., XVI, Part 3, Sect. Orthop. p. 12, 1923.
7. Carl: Isolierte Abrissfraktur des Trochanter minor femoris. Deutsche Ztschr. f. Chir., CLXXIX, 266–268, 1923.
8. Balensweig, I.: Traction Fracture of the Lesser Trochanter, J. Bone & Joint Surg., VI, 696–703, 1924.
9. Ludloff, quoted by Eberstadt, F.: Klinische Untersuchungen über Lähmung des Musculus iliopsoas. München. med. Wchnschr., LXVI, 1026–1031, Sept. 5, 1919.

ARTHROPLASTY OF THE HIP*

BY W. S. BAER, M.D.

Associate Professor of Orthopaedic Surgery, Johns Hopkins University, Baltimore, Md.

In 1909, I presented to the Society a report of eight cases of arthroplasty, five of which were done with the use of an animal membrane. One of these cases was an arthroplasty for tuberculosis of the hip, performed in April, 1908. Ten years elapsed, and I then presented a series of one hundred arthroplasties of various joints, fifty of which were arthroplasties of the hip. It is now eighteen years since the first operation, a period long enough to allow one's first enthusiasm to cool, a period which will permit of careful analytical scrutiny. I should like to analyze now one hundred cases of arthroplasty of the hip, all of which were done with the interposition of an animal membrane, taken from the sub-mucosa of the pig's bladder, and chromicized to remain *in situ* for fifty days.

Most all workers in this field recognize the necessity of an interposing substance in making a movable joint. It has been more than interesting to watch the different types of interposing tissues, which have followed one another, as we have better understood the pathological and physiological changes which are taking place in the formation of a new joint.

Inorganic Transplant.—Klumsky recommended non-absorbable materials as zinc, tin, rubber, silver, and celluloids in the reconstruction of a new joint. Orlow soon followed by recommending the use of metal plate. All inorganic materials have been discarded.

Muscle Transplant.—Naturally one of the earliest materials to be used was a flap of muscle (Mikulicz, Ollier, Helferich, Lintz, Henle, Rochet, Nélaton, Tubby), the idea being that the transplant would live and, owing to its bulky consistency, would act as a bumper between the ends of the bones. We now know that the muscle dies and undergoes degeneration, and that its size prevents us from doing a true arthroplasty. The use of a muscle flap, therefore, has practically been discarded.

Fascia-Fat Transplant.—Owing to an erroneous idea that pedicled flaps would remain viable if inserted between ends of bones which were to make a new joint, this substance was used as the interposing tissue. Its greatest advocates were the late J. B. Murphy and many of his disciples. This method is still slightly used, particularly in South America, but has been superseded for the most part by free fascia.

Fat Graft.—Owing to the action of fat on tissue, De Jiraslk used a graft of fat, but this type of graft does not seem to have been taken up by the profession.

Free Fascial Flaps.—When it was discovered that pedicled flaps

*Read before the American Orthopaedic Association at Atlanta, April 27, 1926.

did not live, and that the removal of a small amount only was compatible with a good arthroplasty, the free fascial flap came into use. This could be obtained more easily and with less damage to the human body; it could be handled more readily, and it required less space for its insertion. It has been advocated and used by such men as Payr, Putti, Monjardino, Hallopeau, Groves, MacAusland, Dickson, Campbell, Cesarano, and others. While a few surgeons still use a pedicled fascial flap, in America, Germany, and Italy the use of a free flap of fascia is the general rule.

Animal Membrane.—In 1909, long before the days of free fascial flaps, I advocated the use of an organic fibrous membrane. It seemed to me that we needed an interposing material that could be easily handled, a material which was not tied to some other part of the human body, and hence restricted in its usefulness.

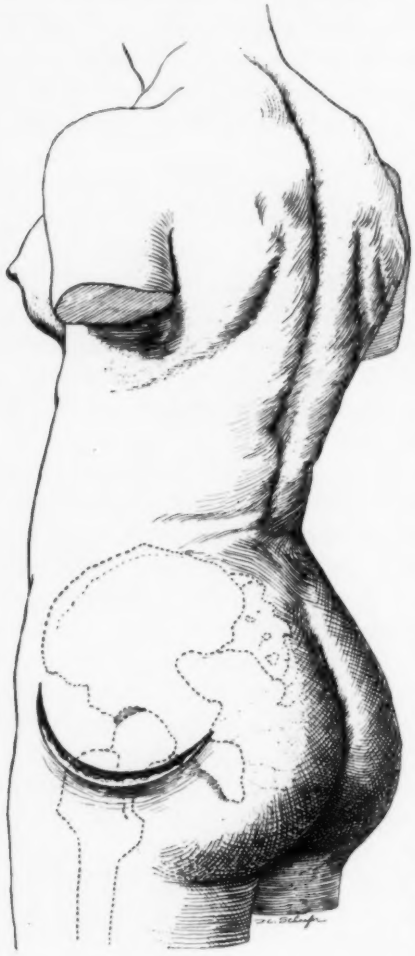


Fig. 1

Skin incision for membrane arthroplasty of the hip.

It should be thin enough to be inserted between even a normal joint. It should remain *in situ* for a length of time sufficient to form the connective tissue cells over the raw bone. This membrane is now used throughout the world, and ranks second in use to the free fascial flap. It is the interposing substance which has been used in the series of one hundred arthroplasties of the hip.

Advantages of the Animal Membrane.—I believe the advantages claimed for the membrane have been proven as years have elapsed. We have seen the day of the pedicled muscle flap and pedicled fascia-fat flap come and go. The large dissections they demanded are now operations of the past.

The membrane, as the fascia, can be inserted within the smallest possible space, thus allowing the topography of the new joint, both in shape and size, to conform as nearly as possible to the original. The greater the resection, the greater the newly formed joint differs, in size and shape, from the original, the greater will be the limp, the greater the instability, the less perfect the motion.

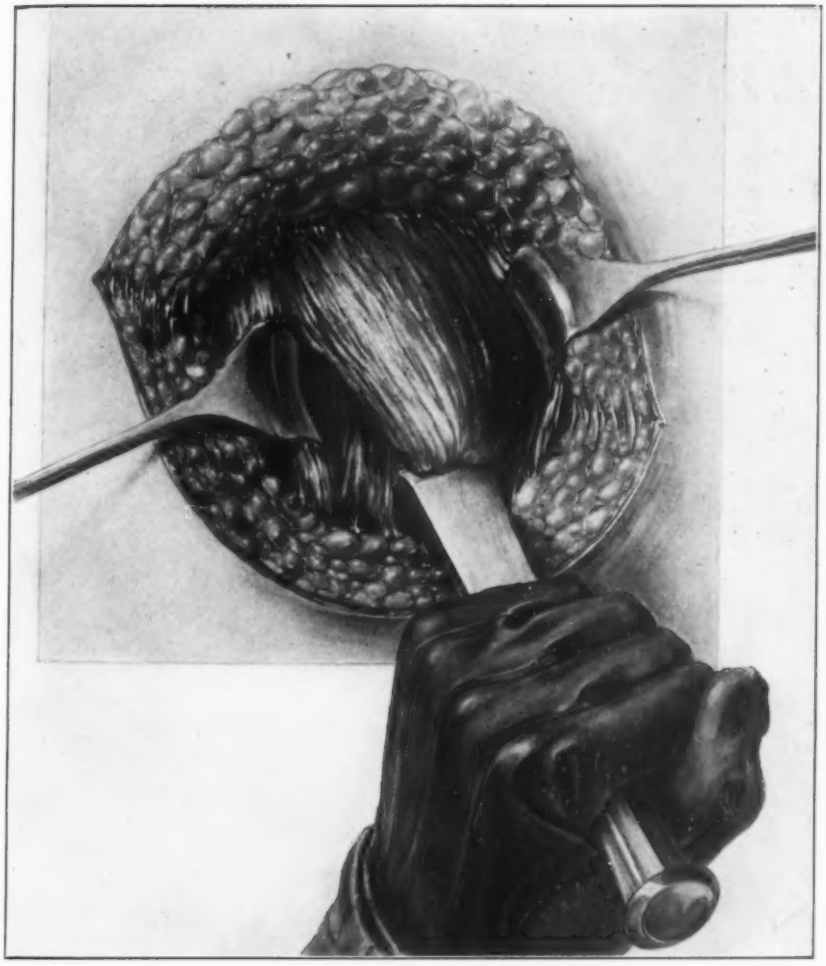


FIG. 2

Removal of the trochanter with soft parts attached.

Those who have written on the experimental side of production of motion in newly made joints concede that the lining of the joint is made of connective tissue cells. These cells are the result of the action of the bone on the fibrous interposed membrane (Magnus, Phemister, Allison and Brooks, Schmertz). In this regard, the membrane and fascia act in a similar manner.

To me, however, the membrane is preferable to the fascia. It is always on hand, as is your catgut. It is manufactured by Johnson and Johnson of New Brunswick, New Jersey, and placed in sealed glass tubes, which can be sterilized as your ordinary catgut. It is part and parcel of your surgical equipment. A second operation, therefore, does not have to be performed on the patient in order to obtain the interposing material.

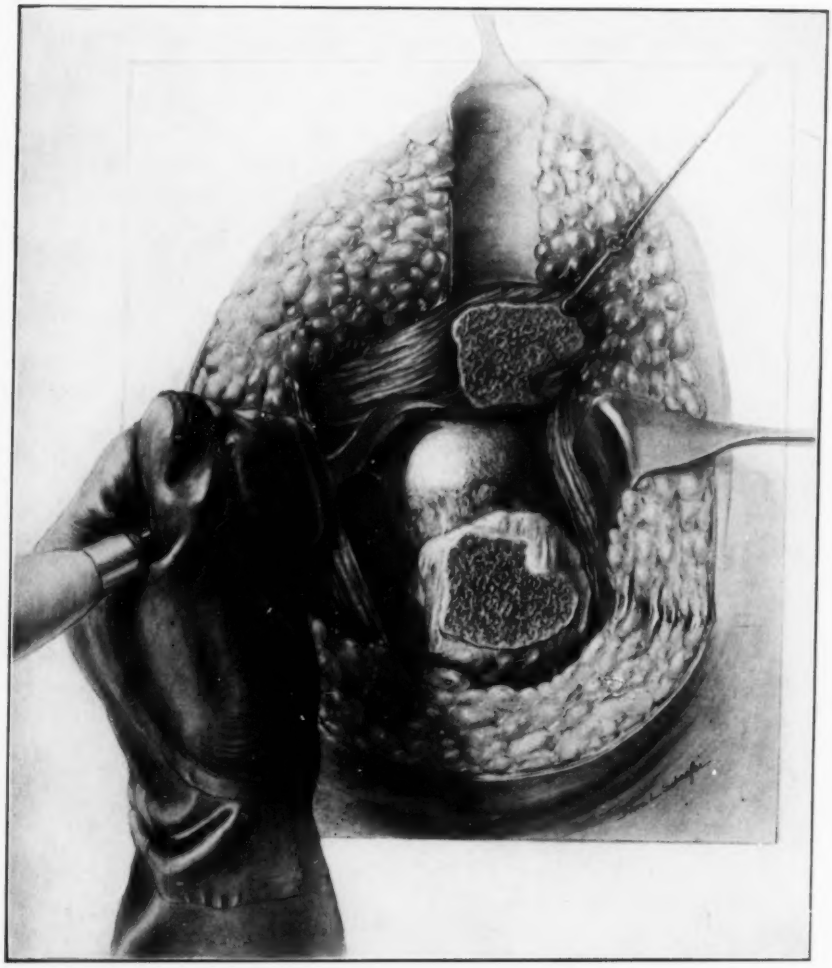


FIG. 3

Chiselling of the head from the acetabular cavity.

There is no danger of producing a hernia of the muscles, owing to the necessity of removing a large area of fascia for the interposing membrane.

The membrane is absolutely hole-proof, in contra-distinction to some of the fascia I have seen removed. If the integrity of the interposing flap is not perfect, at that point adhesions are bound to follow, and ankylosis will occur.

The time of the operation is reduced, for there is only one operation to be performed, namely, the arthroplasty.

There have been two criticisms raised against the use of the membrane: first, that the chemical reaction of the membrane was so intense that adhesions were formed (Allison and Brooks). I believe this criticism was justified. One supposed that it took a long time for the formation of a

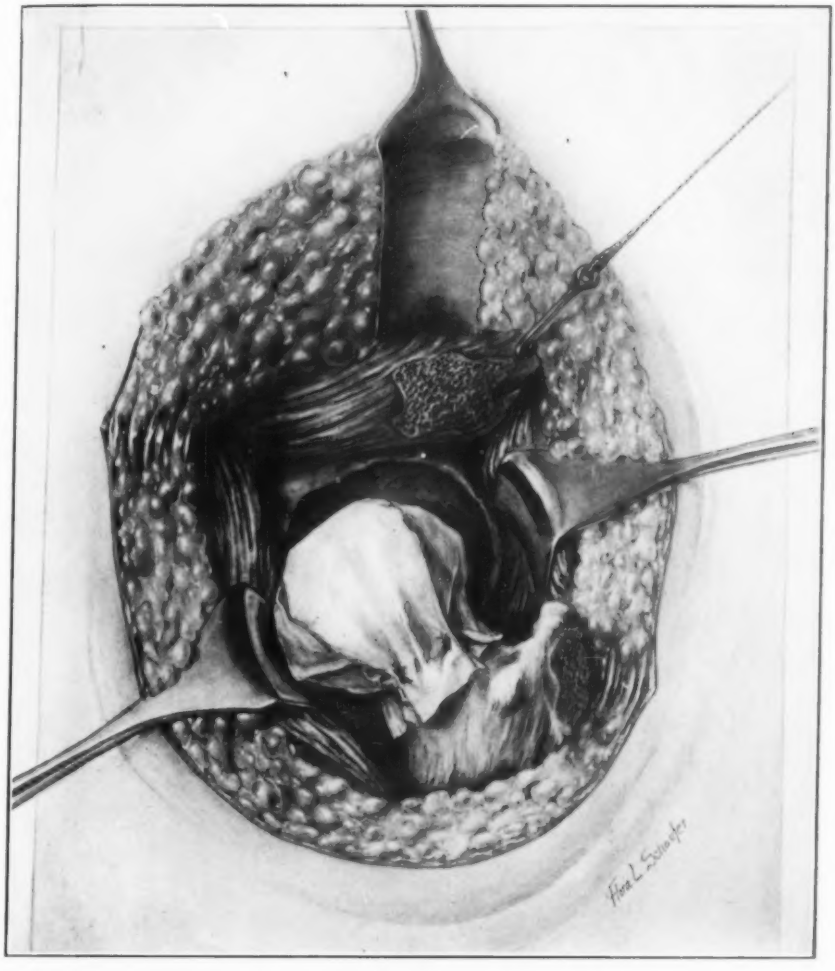


FIG. 4

New acetabulum made. Dislocated head surrounded by membrane.

joint. The membrane was therefore chromicized to remain intact for a hundred days. Magnus shows that a joint forms fairly quickly. The chromitization of the membrane has been cut down so that it shall be preserved for about forty to fifty days, and this has done away with the violent chemical reaction.

The second criticism pointed to the fact that the membrane was at times extruded from the wound. Naturally, with the cutting down of the chromitization, this extrusion no longer occurs.

TECHNIQUE OF ARTHROPLASTY OF THE HIP WITH THE ANIMAL MEMBRANE

Thorough preparation of the operative field is made with iodine technique. An Ollier-Mikulicz incision exposes the trochanter major.

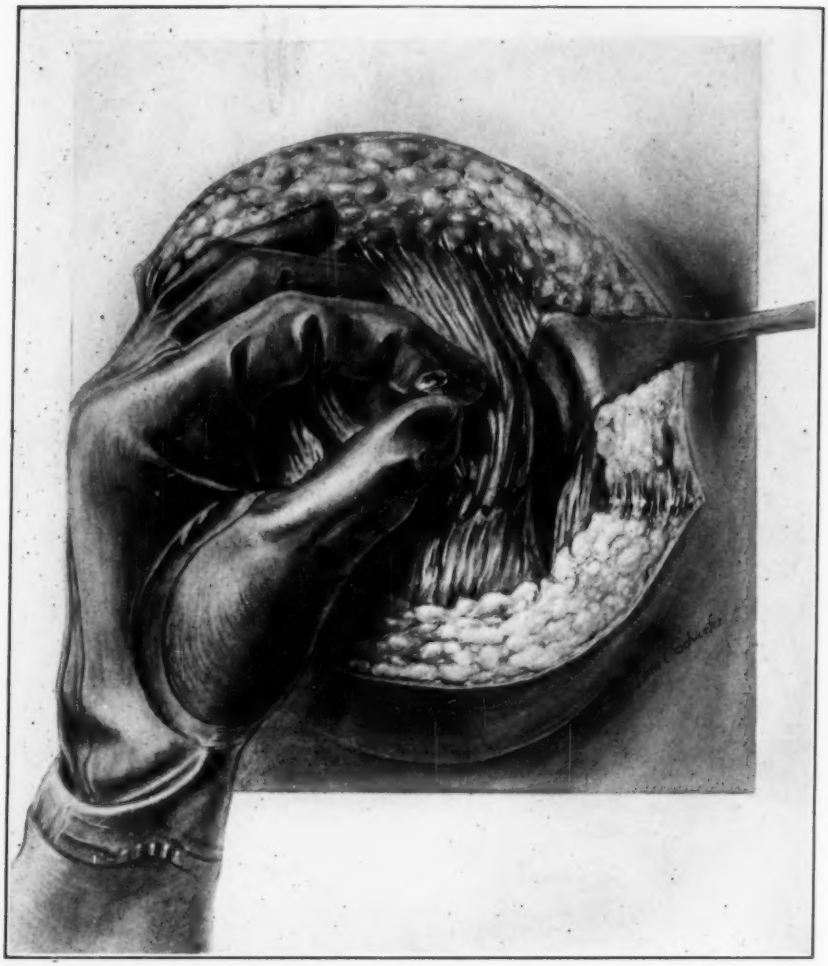


FIG. 5

Nailing of the trochanter after the subluxation has been reduced.

The trochanter, with its attachments, is turned back, and the neck and head of bone, as well as the part of the ilium immediately above the acetabulum, are exposed. The capsule is split parallel with the neck and stripped from the underlying bone. With a wood carver's gouge, the head is separated from the acetabulum. Quite often, one can find no line of demarcation between the femoral head and the acetabulum. One must then chisel through the bone where one supposes the old articulation to have been. The head is now delivered completely from the acetabulum. It is rounded off and then filed down, making it as smooth as possible. The acetabulum is now curetted and reamed out, making it large enough to receive the head. The smallest possible amount of bone should be

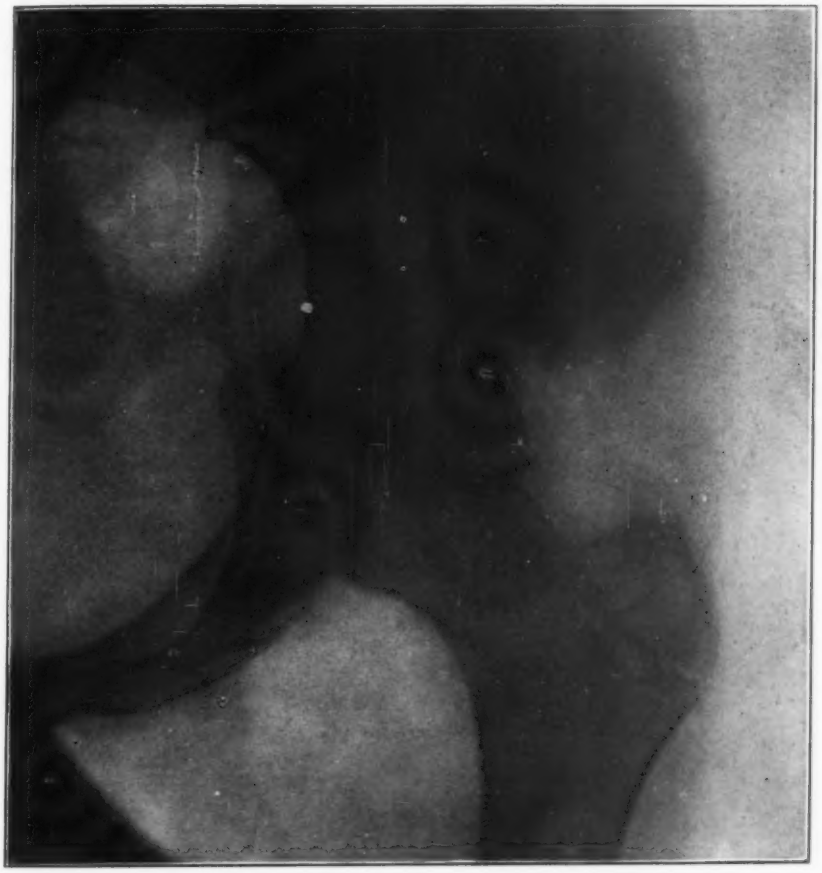


FIG. 6

CASE 1-A. Tuberculous arthritis of the right hip, with ankylosis. X-ray taken before operation.

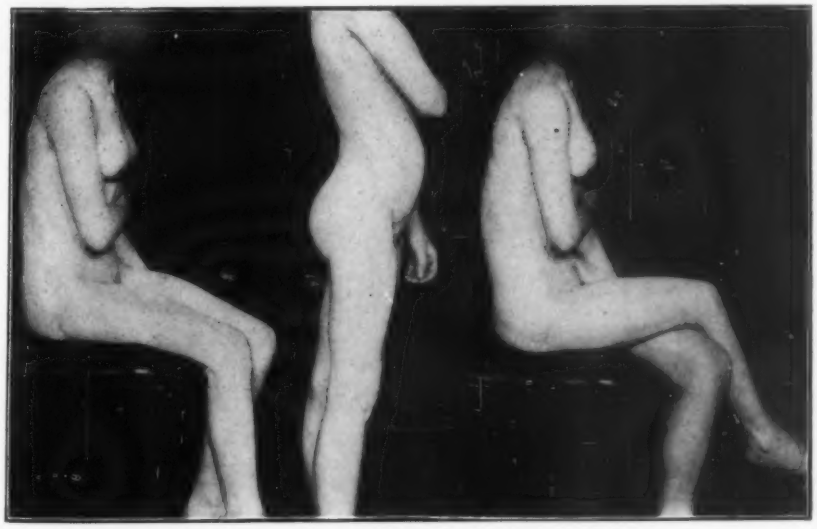


FIG. 7

CASE 1-B. Tuberculous arthritis of the hip, with bony and fibrous ankylosis. Membrane arthroplasty: Dec. 1910. Result two years after operation.

removed. Indeed we should cleave to the old lines of the joint, both head and socket if possible. The head of the bone and the acetabulum should be kept as near the normal size as possible. Remember we are doing an arthroplasty and not a resection. All fibrous tissues in the neighborhood of the joint should be sacrificed. All tissues which tend to form bone should be handled with the greatest care.

The membrane, which has been previously immersed in salt solution for ten minutes, is now placed about the newly formed head and sewn, with forty-day chromic catgut, to the fibrous covering at the distal portion of the femoral neck. Thus the head and the neck of the bone are covered

FIG. 8

CASE 1-C. Tuberculous arthritis of the hip, with ankylosis. X-ray taken fifteen years after operation.

by a sac, as it were. Care must be taken not to tear or perforate the membrane.

The covered head is now replaced in the newly formed acetabulum. The trochanter is nailed to the shaft, at the point from which it was removed. The fascia lata is brought together with forty-day chromic catgut. This skin is sewn with subcutaneous silver wire. Great care should be used to ensure complete haemostasis, as no drainage is used in these cases. The leg is now encased in plaster, from the nipple line to the toes, the position being one of 25° abduction and slight internal rotation.

AFTER-TREATMENT.—The leg remains in this plaster cast for forty-

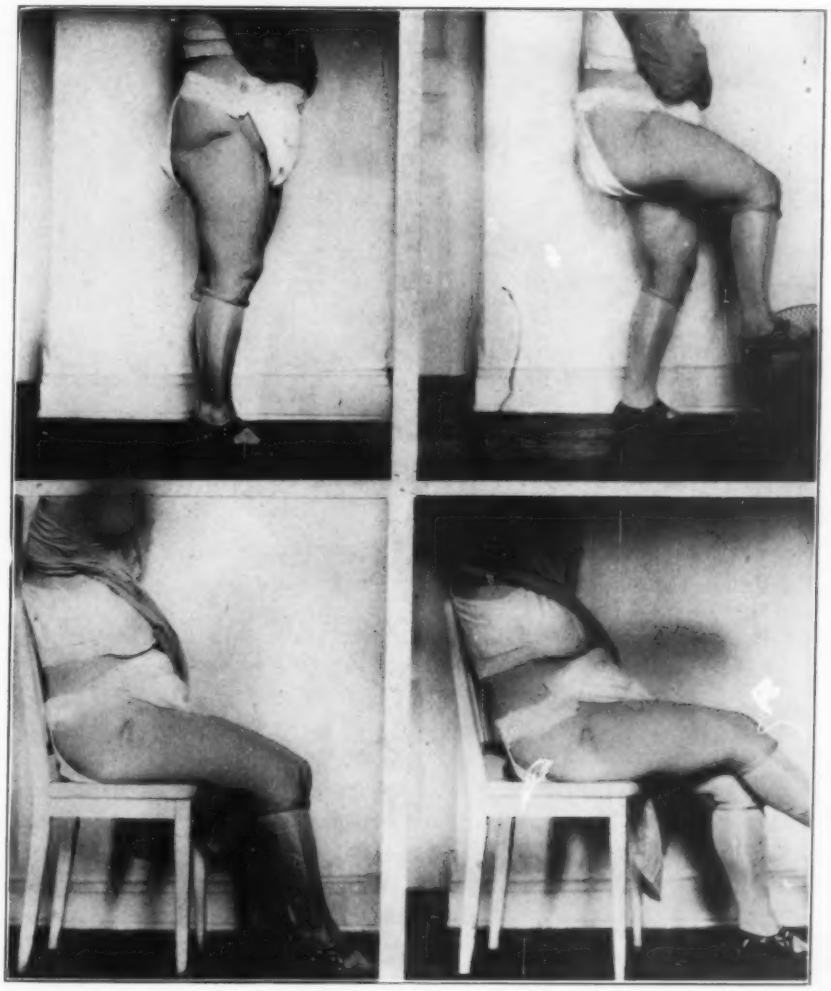


FIG. 9

CASE 1-D. Tuberculous arthritis of the hip, with bony and fibrous ankylosis. Membrane arthroplasty: Dec. 1910. Result fifteen years after operation.

FIG. 10

CASE 2-A. Tuberculous arthritis of the hip, with ankylosis. X-ray taken before operation.

eight hours, so as to control, by pressure of the bandage, any possible hemorrhage. The cast is then removed, and the leg placed in a Thomas traction splint, with a pull of twenty pounds. The splint is suspended from a Balkan frame, which gives comfort to the heel and allows better traction.

In this manner the leg is left absolutely alone until the twenty-first day. The splint is then removed and the silver wire pulled out. For one more week the patient is allowed to remain in bed and to use voluntary active movements of his own hip. At the end of the fourth week he is given crutches and allowed to bear weight on his affected leg. Voluntary motions and active exercises are encouraged. Massage and passive motion

FIG. 11

CASE 2-B. Tuberculous arthritis of the hip, with ankylosis. X-ray taken after operation.

are instituted. Shortly afterwards, mechanical therapy and thermotherapy are started. As soon as possible, a cane is substituted for the crutch. From now on the range of motion gradually increases. One should not forcibly try, under anesthesia, to hasten matters, but by gentle massage and mild passive motion progressively stretch the peri-articular tissues. Limitation of motion is not generally due to a poor arthroplasty, but is due to the stiffness and unstretchableness of the peri-articular tissues incident to the pathology which caused the ankylosis. Care should have been taken preceding or at the time of operation, to remove all scars and thick fibrous tissue.

From now on, the range of motion in the hip will increase. It has been interesting to note the greater range of motion between six months and five years after operation.

ANALYTICAL STUDY OF ONE HUNDRED CASES OF ARTHROPLASTY WITH THE USE OF ANIMAL MEMBRANE

In 1918 the following table was made of the results of fifty arthroplasties of the hip: Series A (1908–1918).

	Good results
9 cases of Gonorrheal Arthritis	89 per cent.
21 cases of Tuberculous Arthritis	66 " "
15 cases of Septic Infection	100 " "
5 cases of Arthritis Deformans	60 " "

(Today, April 1926.) Fifty arthroplasties of the hip. Series B (1919–1926).

	Good results
10 cases of Gonorrheal Arthritis	100 per cent.
6 cases of Tuberculous Arthritis	100 " "
28 cases of Septic Infection	75 " "
4 cases of Arthritis Deformans	50 " "
2 cases of Fracture	100 " "

Combined statistics of Series A and B. One hundred cases of arthroplasty of the hip.

	Good results
19 cases of Gonorrheal Arthritis	95 per cent.
27 cases of Tuberculous Arthritis	74 " "
43 cases of Septic Infection	82 " "
2 cases of Fracture	100 " "
9 cases of Arthritis Deformans	55 " "

GOOD RESULTS OF ARTHROPLASTY OF THE HIP: 82 per cent.

What constitutes a good result in arthroplasty of the hip? The minimum amount of voluntary flexion must be at least 25°. *Other things being equal,* a hip which possesses 25° of flexion is far superior to a stiff hip. The gait is much more elastic and natural, for we only use about 25° of flexion in the act of walking.

The ease and grace of sitting is far better than that of a rigid joint.

The joint must be painless. One must be entirely unconscious of pain and discomfort in the use of the joint.

The joint must be stable in weight-bearing. The hip joint is not only used in locomotion, but has to bear the weight of the body. Thus, while it must have a definite amount of motion for ease of sitting and grace of movement, it must always be stable, securely bearing the weight of the body. One would far better have a stiff, immovable hip joint than a movable one accompanied by weakness. The more nearly the joint is similar, in size and shape, to the original joint, the greater will be the stability.

Hence an arthroplasty, and not a resection!

I call that hip good which has a mobility of 25° as a minimum, a stability which does not require crutch or cane, and is indeed almost as strong as an ankylosed joint, and that is free of pain and discomfort.

Taken in this sense, arthroplasty of the hip, in all types of pathological conditions operated upon, gave us *good* results in 82 per cent. of the cases. I am sure we will more nearly approach the normal range of motion, and the greater will be our percentage of good results, as we learn by experience the type of cases we should select for our arthroplasty. The pathological and bacteriological conditions will determine for us the time of operation and whether an arthroplasty should be attempted.

ARTHROPLASTY FOLLOWING FRACTURES.—In this series there are two cases of fracture of the femoral head and acetabulum with bony ankylosis. The arthroplasty has given excellent results with a possible flexion of 70° and 80°, and without pain. There is some limp in each case, owing to the destruction of bone, incident to the fracture, but there is no pain, and the motion is quite free. This type of case lends itself well to arthroplasty,

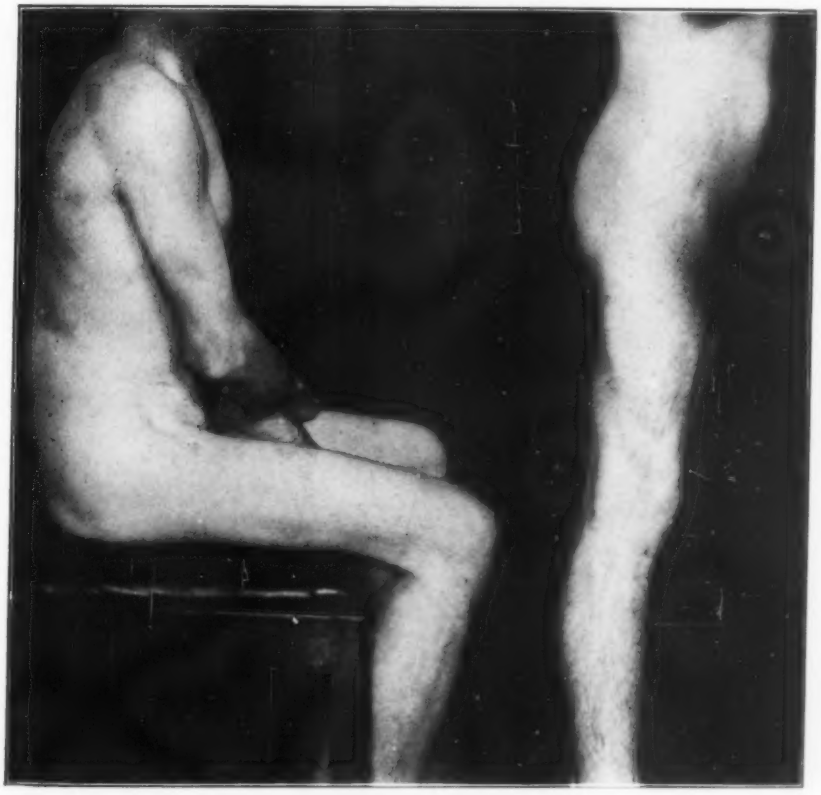


FIG. 12

CASE 2-C. Tuberculous arthritis of the hip, with complete bony ankylosis. Membrane arthroplasty: May 1909. Result almost two years after operation.

because the peri-articular tissues are normal, unlike that which follows disease. This is also the experience of Putti, Riosalido, and others.

Gonorrheal Arthritis of the Hip.—There are nineteen cases in this series, with good results in 95 per cent. The range of flexion is as follows: one case 20°, three cases 25°, one case 35°, one case 40°, one case 45°, one case 50°, one case 60°, five cases 90°, one case 95°, three cases 100°, one case 110°. That is, more than fifty per cent. of these patients could sit down with their legs flexed to a right angle. Hips of this type are steady, painless, and have increased in motion year by year, as was to be expected when one considers the nature of the disease. One can almost

Fig. 13

Case 3-A. Chronic infectious arthritis of the left hip, following influenza, pleurisy and empyema. X-ray taken after operation.

promise a good result in the hip in gonorrheal infection if certain rules are observed. This view is concurred in by Hohlbaum, Putti, Riosalido, and, others. It is very difficult for me to understand the position of Prando, who thinks the results in gonorrhea are the worst of all arthroplasties. It certainly has not been my experience.

Never perform an arthroplasty in the acute stages of gonorrheal infection. Wait at least for one year after all acute symptoms have disappeared before advising operation. The thickened capsule and peri-articular tissues recede slowly. They are very fibrous in the early stages and have lost their elasticity. New bone formation and fibrous ankylosis are much more apt to occur if the operation is done too soon. Remove all fibrous tissue

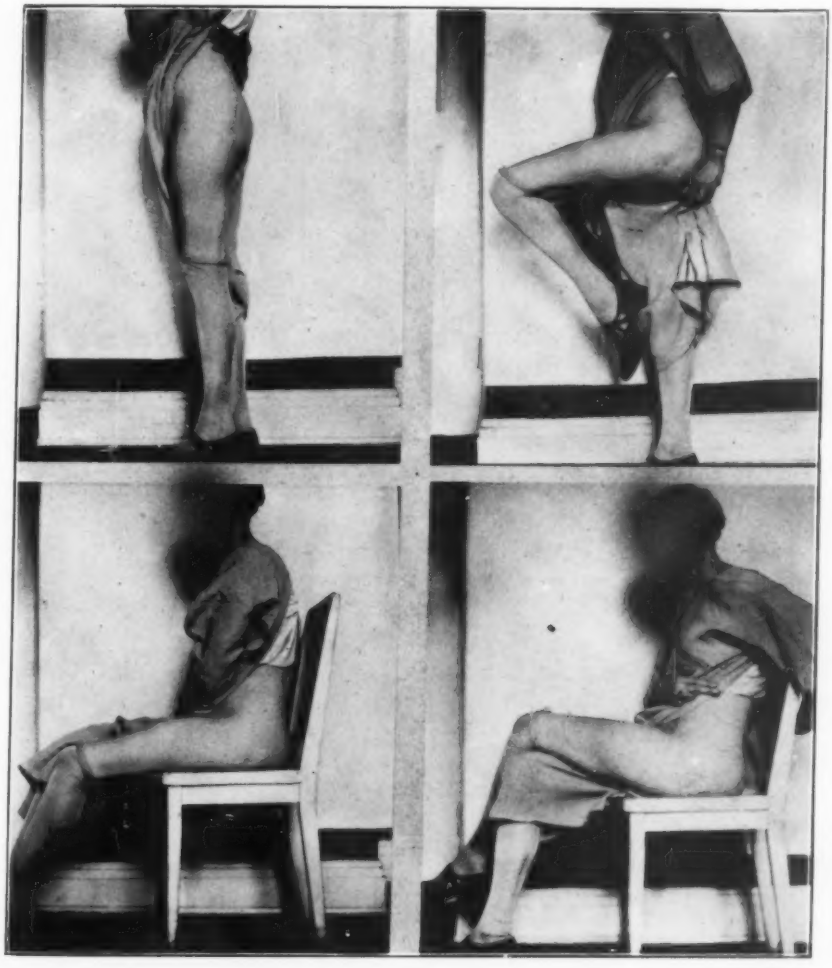


FIG. 14

CASE 3-B. Chronic infectious arthritis of the hip, following influenza, pleurisy and empyema. Fibrous and bony ankylosis of the hip.
Membrane arthroplasty: Oct. 14, 1919. Result six years after operation.

about the joint and handle bone and its covering with care. In my experience the gonococcal infections, next to traumatism, give the best results in arthroplasties of the hip.

Septic Infections of the Hip.—An arthroplasty has been performed forty-three times in this class of infection. The most prevalent organism is the staphylococcus aureus, and the streptococcus, although there are a few cases of the influenza bacillus and one of pneumococcus.

We have succeeded in making a satisfactory hip in 82 per cent. of the cases, nevertheless the range of motion is not so great as in the cases of Neisser infection, and the risks, both as to mortality and infection, are much greater. The following is the voluntary flexion produced in this group: seven cases 0°, one case 15°, one case 25°, four cases 30°, one case 35°,

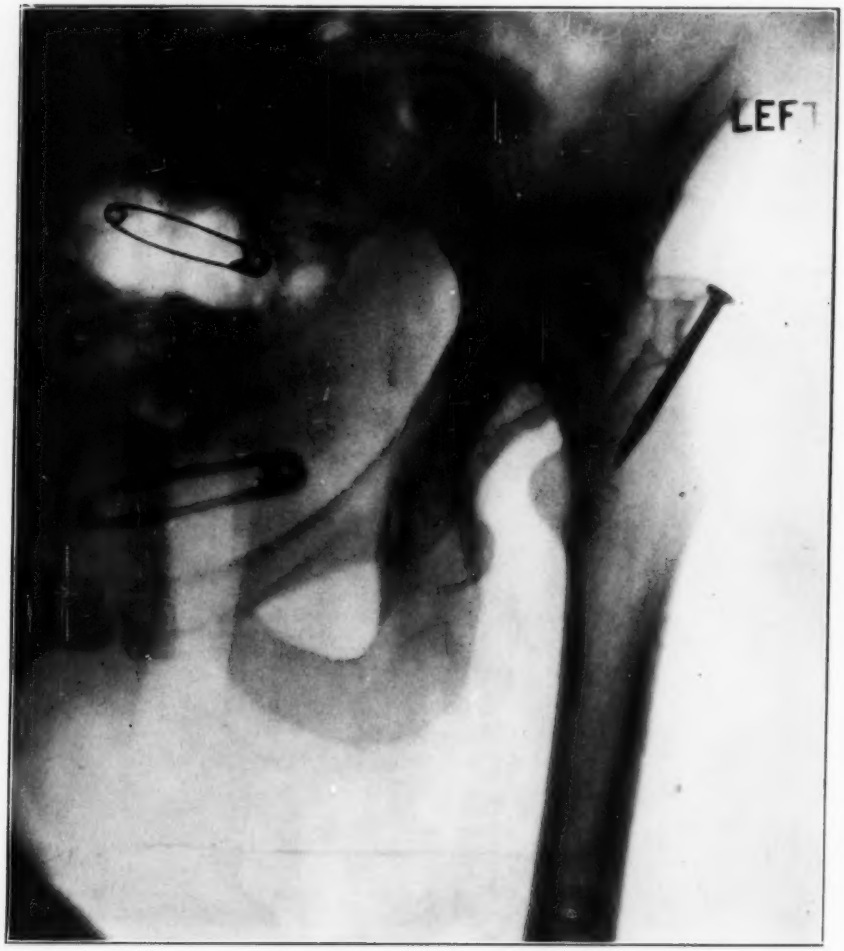


Fig. 15

Case 4-A. Infectious arthritis of the hip, following acute rheumatic fever. X-ray taken after operation.

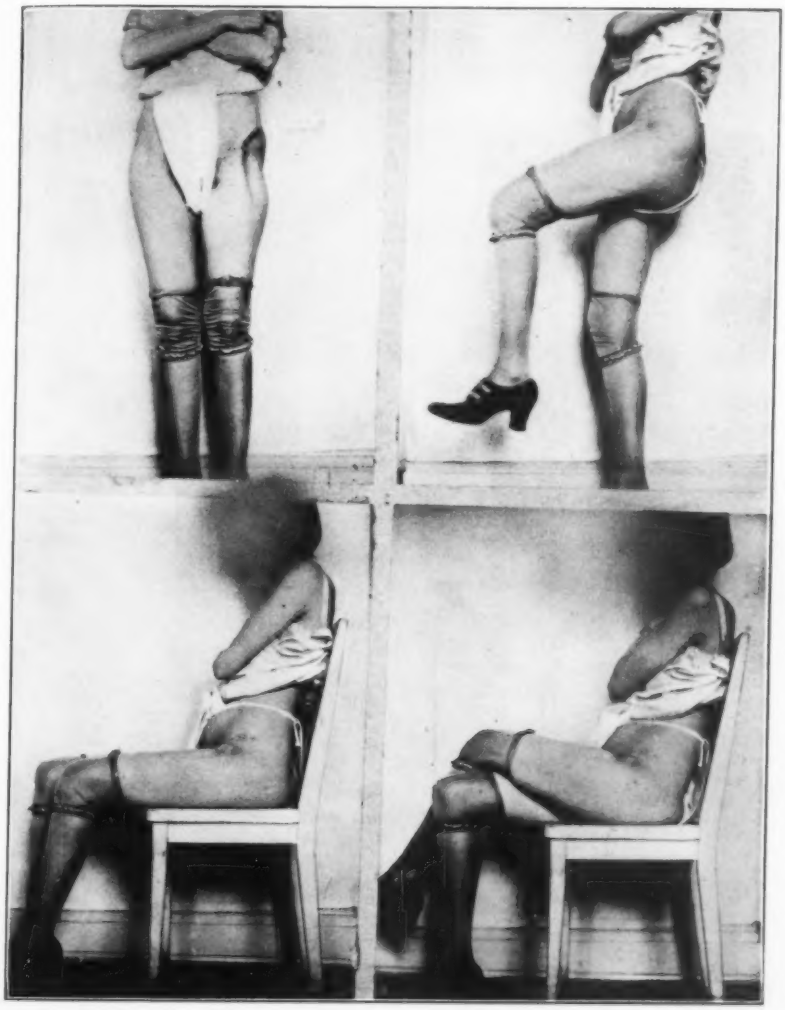


FIG. 16

CASE 4-B. Infectious arthritis of the hip, following acute rheumatic fever. Membrane arthroplasty: June 24, 1919. Result six years after operation.

one case 40°, six cases 45°, four cases 50°, six cases 60°, three cases 70°, two cases 75°, one case 80°, five cases 90°, one case 100°.

The cases should be selected with extreme caution. The general condition should be taken into consideration, as well as the local area. Fat people who have had a long suppurative history should be avoided. It is needless to say that a case with a suppurative sinus, or in the acute stage, should never be touched.

Indeed all signs of activity should have ceased at least two or three years before operative interference is contemplated. Where large scar formations exist, a preliminary operation for their removal is indicated.

FIG. 17

CASE 5-A. Chronic infectious arthritis of the right hip with fibrous and bony ankylosis. X-ray taken after operation.

The mortality of arthroplasty of the hip, in this series of one hundred arthroplasties, has been three per cent., and each of these deaths occurred in this division of septic infection. The patients, owing to long suppurative processes, do not stand the operation as well as in the other groups.

We are more liable to set up a secondary infection at the local site of operation, owing to the presence of a living organism, although clinically the patient may appear to be well. When this occurs, the result desired is vitiated.

However, if these cases are picked with great caution, if the patient is in excellent condition, if the suppurative process has been over for more

than two years, and if the amount of scar tissue is not too great at site of operation, this group will give results which are very favorable.

TUBERCULOUS ARTHRITIS OF THE HIP.—There are twenty-seven cases of this nature in this series. The following amount of flexion has been obtained: seven cases 0°, four cases 30°, two cases 45°, two cases 50°, one case 60°, one case 65°, one case 75°, five cases 90°, two cases 100°, and one case 110°. This gives good motion in 74 per cent.

It will be noted that twenty-one of these cases were operated on before 1918, and only six since. In the series before 1918, one-third of the cases resulted in relighting the tuberculosis, although this has invariably quieted down, with a subsequent stiff hip. Fearing, therefore, to set up tuberculosis, I have been much more conservative in the second series, and only

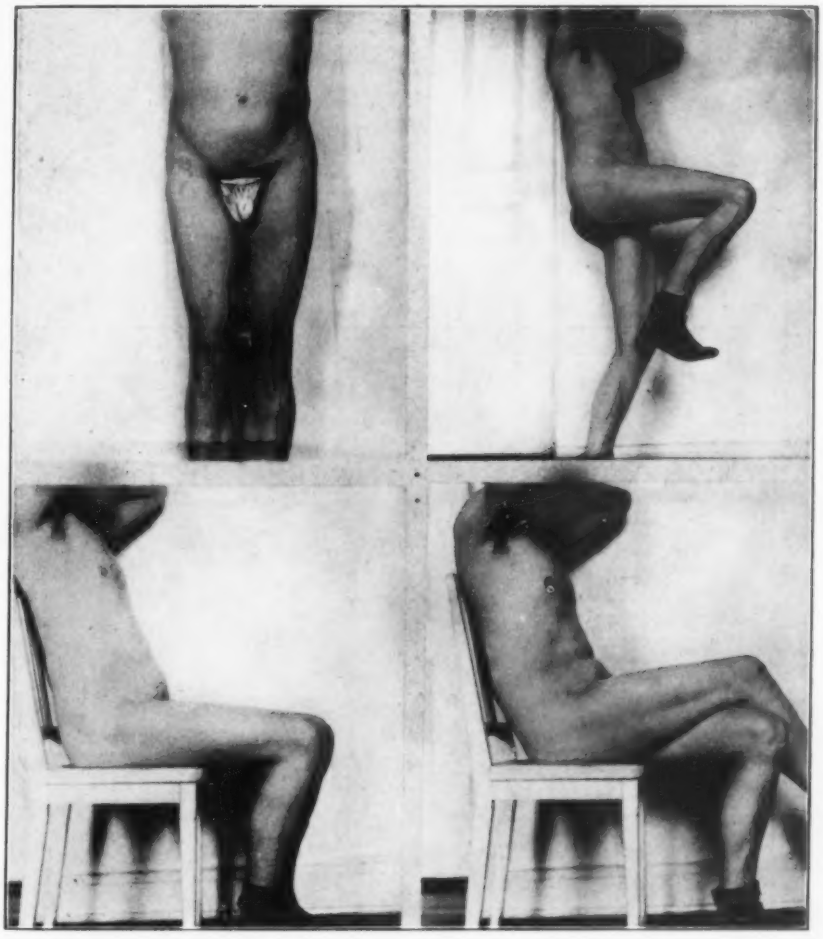


FIG. 18

CASE 5-B. Chronic infectious arthritis of the hip, with fibrous and bony ankylosis. Membrane arthroplasty: July 7, 1922. Result four years after operation.

FIG. 19

CASE 6-A. Infectious arthritis of the hip, probably gonorrheal. X-ray taken before operation.

FIG. 20

CASE 6-B. Infectious arthritis of the hip, probably gonorrheal. X-ray taken after operation.

six cases have been attempted. Strange to say, however, each one of these six cases has given good results. This goes to show that, while the operation carries with it its risks, nevertheless, if the case is a suitable one, there is a good chance of great improvement.

In the first place, no child should be operated upon. This also applies to the septic group. There is no doubt that the poor results in Series A were on account of the violation of this rule, a violation which was done wittingly, from an experimental point of view. No child should ever have an arthroplasty performed unless full growth has been attained. One cannot afford to sacrifice the epiphyseal structures.

Most authorities are disinclined to operate upon cases of a tuberculous nature. It should be done only in selected cases where the general health is excellent and where there has been no clinical evidence of tuberculosis

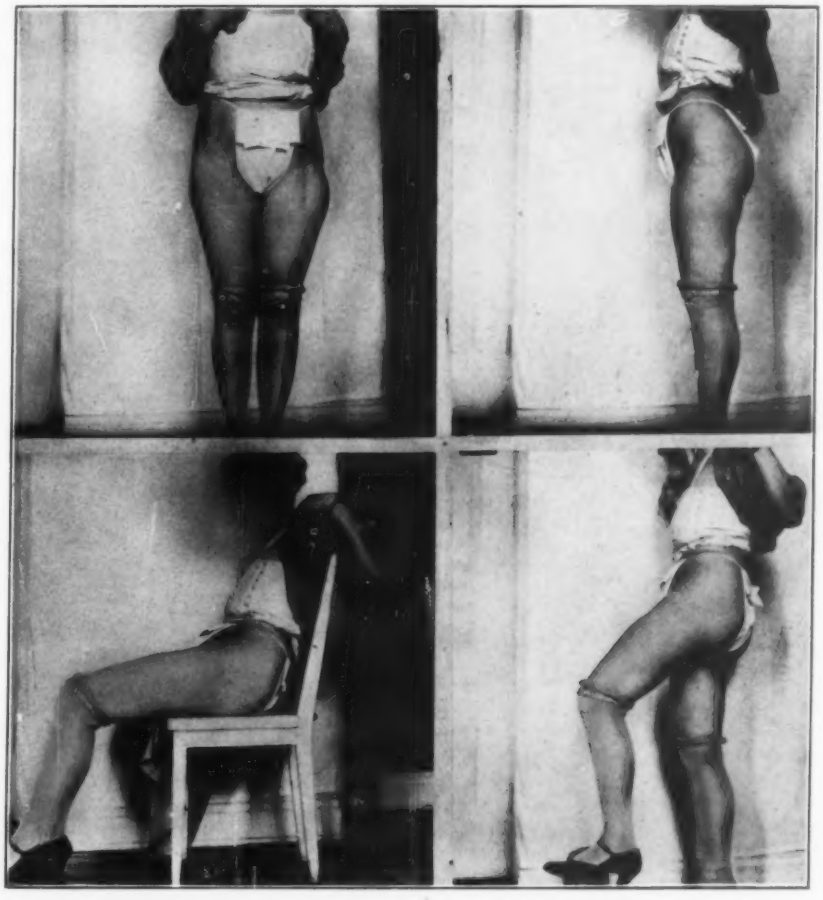


FIG. 21

CASE 6-C. Infectious arthritis of the hip, probably gonorrheal, with a complete fibrous and bony ankylosis.
Membrane arthroplasty: June 24, 1924. Result almost two years after operation.

for years. Even then we may run into a latent area of disease. But in the light of the figures, and in the light of the experiences of all of us, when we did an arthrodesis which did not arthrodese, and when we remember the happy movable results which followed, I believe that in a few carefully selected cases an arthroplasty is justifiable.

ARTHRITIS DEFORMANS.—This group consists of nine cases. The motion in flexion is as follows: four cases 0°, one case 25°, one case 35°, two cases 50°, one case 80°, or fifty-five per cent.

This is a group where arthroplasty is inadvisable, except as a last desperate resort where both hips are ankylosed. The very nature of the

FIG. 22

CASE 7-A. Gonorrheal arthritis of the left hip, with ankylosis. X-ray taken before operation.

trouble, a chronic progressive disease which is still active, tends to negative all our efforts. It is generally agreed that little is to be expected from any arthroplastic operation.

CONCLUSIONS

Arthroplasty for the production of motion, in certain joints and under certain conditions, has taken its place in surgery as a definite procedure. Surely this is the case in Germany, Italy, and America, and to a lesser degree in France, but it cannot yet be said to have gained a foothold in England. Indeed, most English writers seem to be antagonistic to it, but, as only one hundred and forty arthroplasties of all joints have been done in England (Groves, 1924), perhaps a greater experience may change this point of view.

Arthroplasty for ankylosis of the jaw is an operative procedure as permanent and exact as is the operation of appendectomy. I myself have had forty-three operations of arthroplasty of the jaw with but a single failure. That one should not have been attempted, as it was a synostosis of the entire upper and lower jaw in a baby weighing but four pounds at one year of age. I have no hesitancy whatever in promising a cure in ankylosis of the jaw, subject only to the unforeseen happenings to which any operation is prone.

FIG. 23

CASE 7-B. Gonorrheal arthritis of the hip, with ankylosis. X-ray taken after operation.

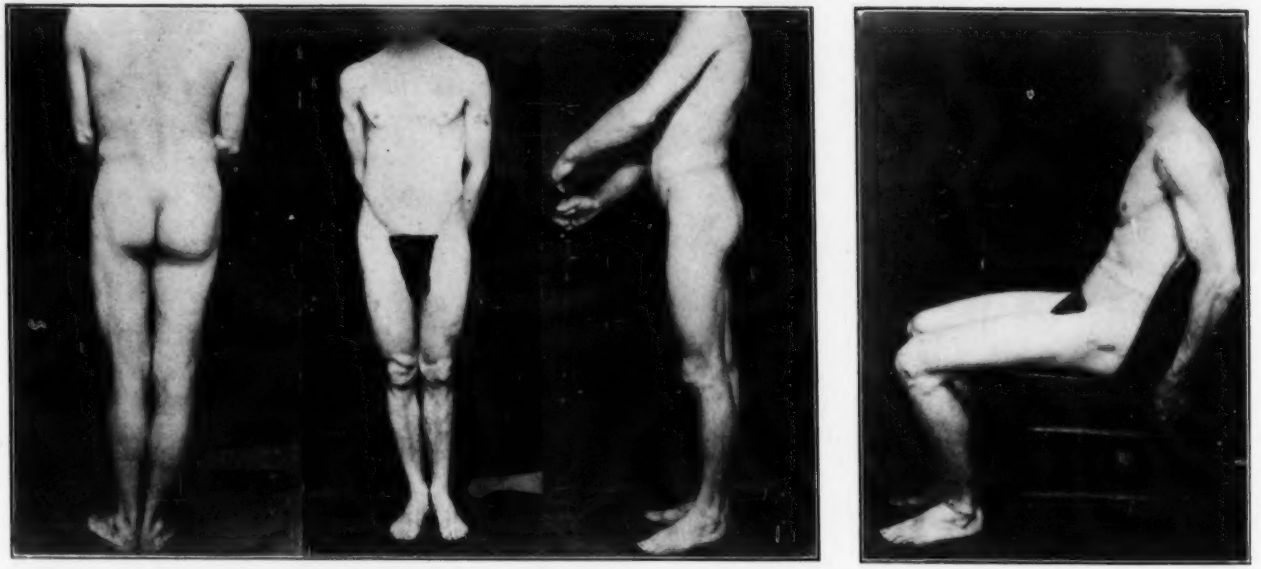


FIG. 24

CASE 7-C. Gonorrheal arthritis of the hip, with fibrous and bony ankylosis. Membrane arthroplasty: March 2, 1922. Result four years after operation.

To my mind, next to the jaw, arthroplasty of the hip has made the greatest strides, and is well on its way of taking its place as a recognized surgical procedure. I believe that arthroplasty of the hip for gonorrheal arthritis is not only a proper procedure, but it almost assures the patient of good motion in the hip with "all the advantages thereunto appertaining". I should not hesitate to recommend such a procedure to any patient applying for relief.

The results of arthroplasty in traumatic ankylosis of the hip are very gratifying.

Our prognosis in septic infection of the hip should be far more guarded,

FIG. 25

CASE 8-A. Gonorrheal arthritis of the left hip, with ankylosis. X-ray taken before operation.

and we should attempt the operation only after the most careful scrutiny of the case, and always with a certain mental reservation. It is difficult to tell what changes have been made in the human body by the previous continuous suppuration. Here we are dealing with latent fire.

In tuberculous arthritis caution should be our motto. Opinion generally is against an arthroplasty. In some adults, apparently cured but with exacerbation of fluid in the joint and its consequent disability, good results may be obtained. In arthritis deformans, almost never!

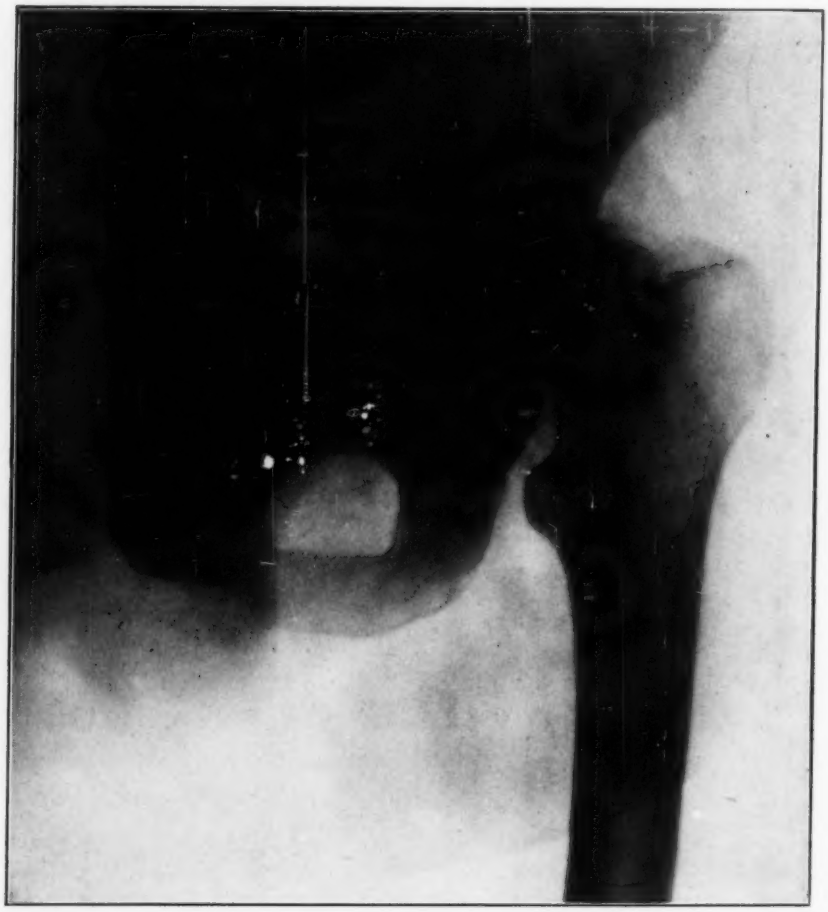


FIG. 26

CASE 8-B. Gonorrheal arthritis of the hip, with ankylosis. X-ray taken after operation.

BIBLIOGRAPHY

ARTHROPLASTY OF THE HIP

ALBEE, F. H.: Plastic Surgery of the Hip and Femur. Surg. Clin. No. Am. Phila. I, 391, 1921.

BALDWIN, A.: A Case of Operation for Bony Ankylosis of the Hip at a Right Angle, Followed by Good Movement. West London Med. J. XX, 111, 1915.

BENGOLEA: Artroplastia de cadera por anquilosis; resultado alejado. Bol. y Trab. de la Soc. de Cirug. de Buenos Aires. VIII, 147, 1924.

BOSCH ARANA: Trochanteroplastia y artroplastia de la cadera. Bol. y Trab. de la Soc. de Cirug. de Buenos Aires. VII, 642, 1923.

BURLEW, J.: Arthroplasty of the Hip Joint. Murphy Method. Report of four cases. Cal. State Med. J. XVI, 237, 1918.

CEBALLOS: Artroplastias de cadera, rodilla y codo. Bol. y Trab. de la Soc. de Cirug. de Buenos Aires. VIII, 142, 1924.

CESARANO, U.: Le anchilosi dell'anca. Ann. di Med. nav. Roma. XXV,–II, 745, 1919.

CORNER, E. M.: A Method of Access to the Hip Joint. Proc. Roy. Soc. Med. London. VII, Surg. Sect. 125, 1913–14.

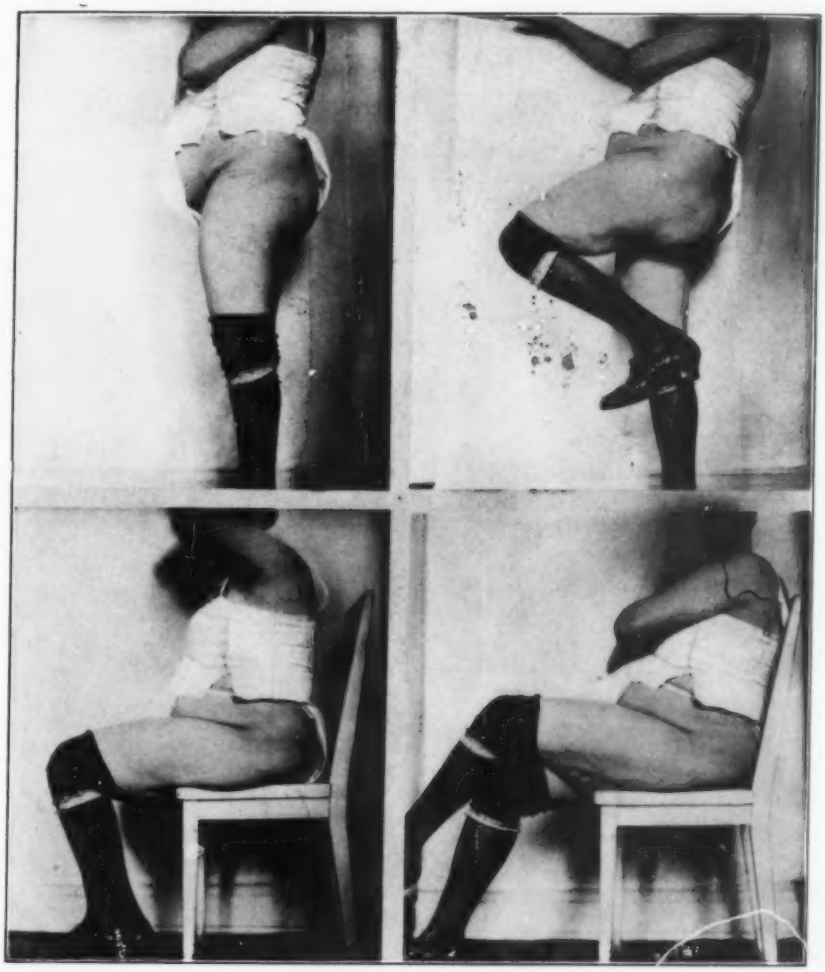


FIG. 27

CASE 8-C. Gonorrheal arthritis of the hip, with ankylosis. Membrane arthroplasty: Jan. 29, 1919. Result seven years after operation.

Dickson, F. D. and Diveley, R. L.: An Operation for the Relief of Ankylosis of the Hip Joint. Surg. Clin. No. Am. Phila. III, 1739, 1923.

Dreyer: Beitrag zur Hüftmobilisierung. Verhandl. d. deutsch. orthop. Gesellsch. Stuttgart. XV Kong. 1920. XV, 342, 1921.

Dupuy de Frenelle: Arthroplastie pour ankylose de la hanche. Paris Chirurg. XVI, 347, 1924.

Elmslie, R. C.: Ankylosis of Both Hip Joints. Proc. Roy. Soc. Med. London. XIII. Surg. Sect. 210, 1919–20.

Evans, Leming: Case of Arthroplasty of Both Hips. Proc. Roy Soc. Med. London. XV, Orthop. Sect. 79, 1922.

Hallopeau, P.: Ankylose double des hanches traitée par intervention bilatérale. Bull. et Mem. Soc. de Chirurg. de Paris. XLVI, 1447, 1920.

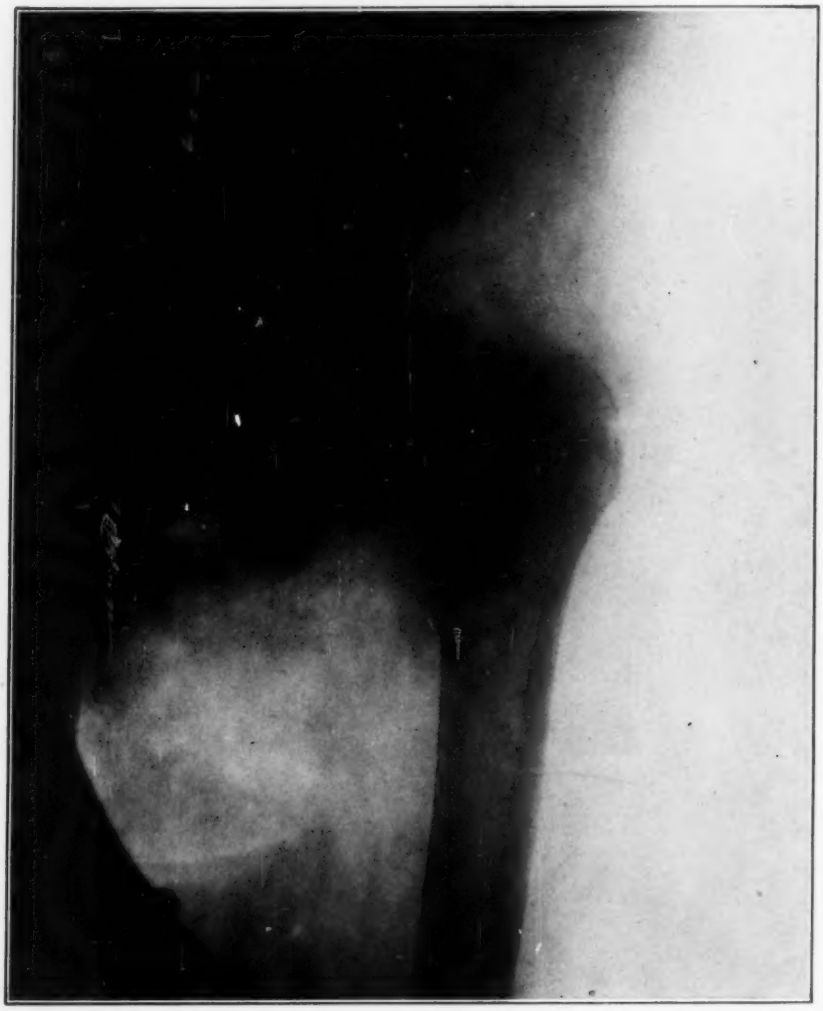


Fig. 28

Case 9-A. Infectious arthritis of the hip, with ankylosis. X-ray taken before operation.

KOFMANN, S.: Zur Frage der Nearthrosenbildung am Koxalgelenk. Zentralbl. f. Chir. L, 1162, 1923.

MCKENNA, H.: Arthroplasty on the Hip. Surg. Clin. of Chicago. Philadelphia. IV, 749, 1920.

MONJARDINO, J.: Artroplastia de anca. Brazil-Med. Rio de Janeiro. XXXVII, II, 144, 1923.

MURPHY, J. B.: Arthroplasty of the Hip. Surg. Clin. of, Chicago. II, 449, 1913.

MURPHY, J. B.: Case of Arthroplasty of the Hip. Surg. Clin. of, Chicago. IV, 239, 1915.

MURPHY, J. B.: Ankylosis of the Hip Joint, Dense and Fibrous in Type, from Ancient Infection. Arthroplasty by the Fat-fascia Flap Method. Talk on Technic of Arthroplasty of the Hip Joint. Surg. Clin. of, Chicago. V, 83, 1916.

FIG. 29

CASE 9-B. Infectious arthritis of the hip, with ankylosis. X-ray taken after operation.

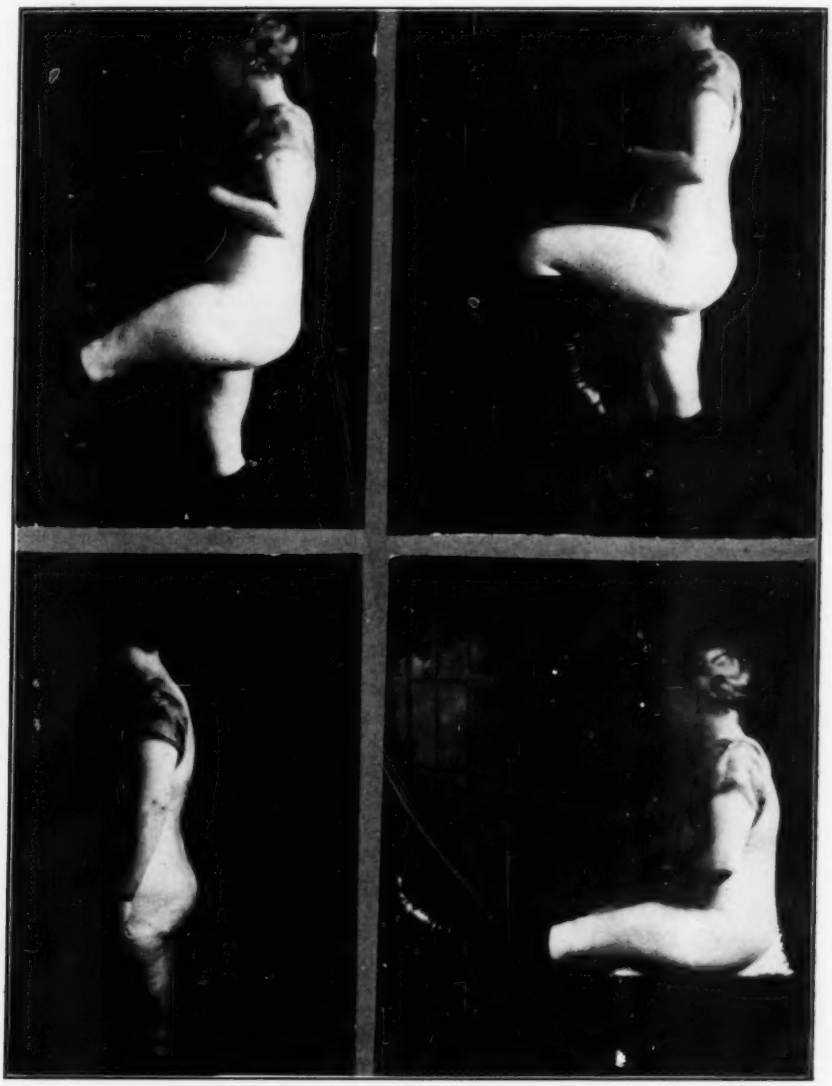


FIG. 30

CASE 9-C. Infectious arthritis of the hip, with complete bony ankylosis. Membrane arthroplasty: Dec. 6, 1916. Result almost ten years after operation.

MURPHY, J. B.: Ancient Tuberculosis of the Hip Joint. Arthroplasty. Tenotomy of Adductors. Surg. Clin. of, Chicago. V, 95, 1916.

PAYR, E.: Mobilisierung aller drei grossen versteiften Gelenke der linken unteren Extremität. Munchen Med. Wchnschr. LXVII, 705, 1920.

PERTHES, G.: Mobilisierung des Knöchern versteiften Hüftgelenks. Munchen Med. Wchnschr. LXIV, 919, 1917.

TAVERNIER, L.: Arthroplastie de la hanche. Rev. d'orthop. Paris. 3ème série, VI, 179, 1918.

TORREY, H. N.: Ankylosis of the Hip. Arthroplasty. J. Michigan Med. Soc. XII, 368, 1913.

TRUSLOW, W.: Mobilization of Ankylosed Tuberculous Hip. Long Island Med. J. XI, 365, 1917.

GENERAL ARTHROPLASTY

ALLISON, N. AND BROOKS, B.: Ankylosis: an Experimental Study. J. Am. Med. Assn. LXIV, 391, 1915.

ALLISON, N. AND BROOKS, B.: Arthroplasty: Experimental and Clinical Methods. Am. J. Orthop. Surg. XVI, 83, 1918.

BAER, W. S.: The Use of Animal Membrane in Producing Mobility in Ankylosed Joints. Johns Hopkins Hospital Bull. XX, 271, No. 222. September 1909.

BAER, W. S.: Arthroplasty with the Aid of Animal Membrane. Trans. So. Surg. Assn. 1916.

BAER, W. S.: Arthroplasty with the Aid of Animal Membrane. Am. J. Orthop. Surg. XVI, 1, Jan., XVI, 94, Feb., XVI, 171, Mar. 1918.

BALDWIN, W. I.: Some Principles of Arthroplastic Operations. J. Am. Med. Assn. LXXVII, 1860, 1921.

CAMPBELL, W. C.: Mobilization of Joints with Bony Ankylosis; an Analysis of One Hundred and Ten Cases. J. Am. Med. Assn. LXXXIII, 976, 1924.

DÉNUCÉ, M.: Procédés sanglants de cure radicale applicables aux ankyloses de chaque articulation en particulier. Gazz. hebd. des Sciences méd. de Bordeaux. XXXIV, 481, Oct. 12, 1913.

FIG. 31

CASE 10-A. Gonorrheal arthritis of the hip, with ankylosis. X-ray taken before operation.

Dickson, F. D.: Arthroplasty. So. Med. J. XVI, 949, 1923.
Eden: Gelenkplastik. Ueber freie Muskeltransplantation. Munchen Med. Wchnschr. LXV, 467, 1918.
Grange, C.: Three Cases of Arthroplasty. Lancet, II, 554, 1920.
Groves, E. W. Hey: Arthroplasty. Brit. J. Surg. XI, 234, 1923–24.
Groves, E. W. Hey and Putti, V.: Arthroplasty. Brit. Med. J. London. II, 142, 1923.
Gukele, N.: Ueber die operative Behandlung völlig versteifter Gelenke. Berlin Klin. Wchnschr. LVIII, 1149, 1921.
Harris, C. H.: Arthroplasty. Texas State Med. J. IX, 213, Nov. 1913.
Henderson, M. S.: What are the Real Results of Arthroplasty? Am. J. Orthop. Surg. XVI, 30, 1918.
Hohlbaum, J.: Erfahrungen und Erfolge nach blutiger Mobilisierung versteifter statisch belasteter Gelenke. Arch. f. Klin. Chir. Berlin. CXVII, 647, 1921.

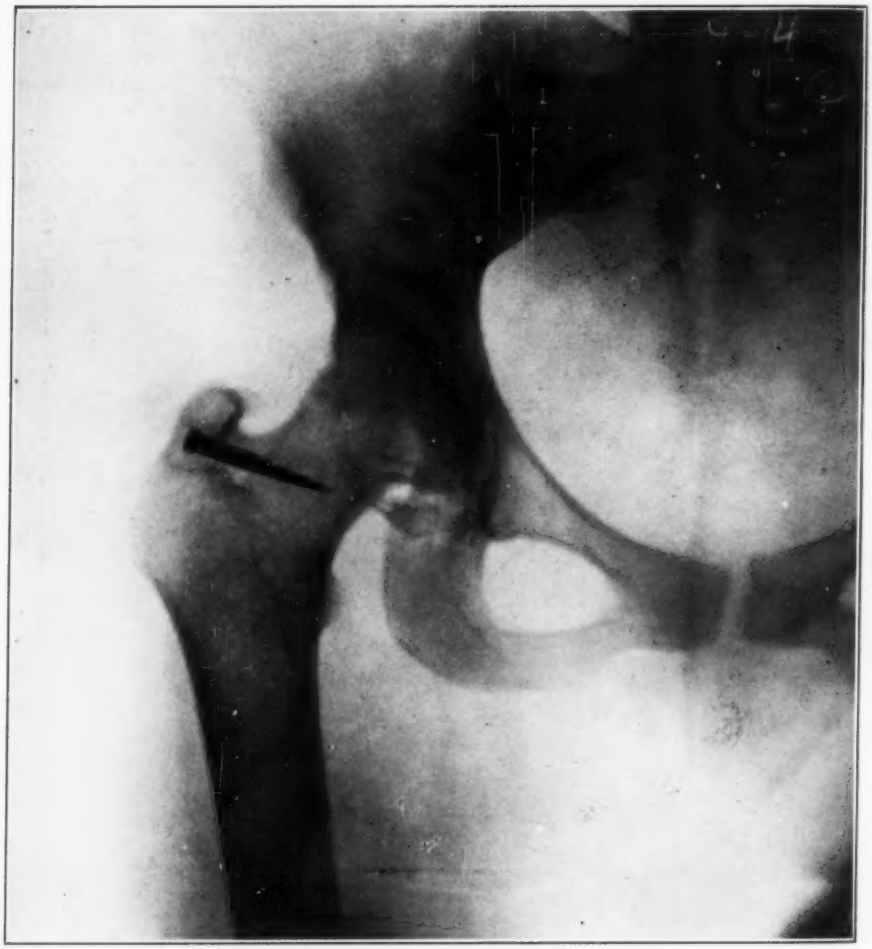


Fig. 32

Case 10-B. Gonorrheal arthritis of the right hip, with ankylosis. X-ray taken after operation.

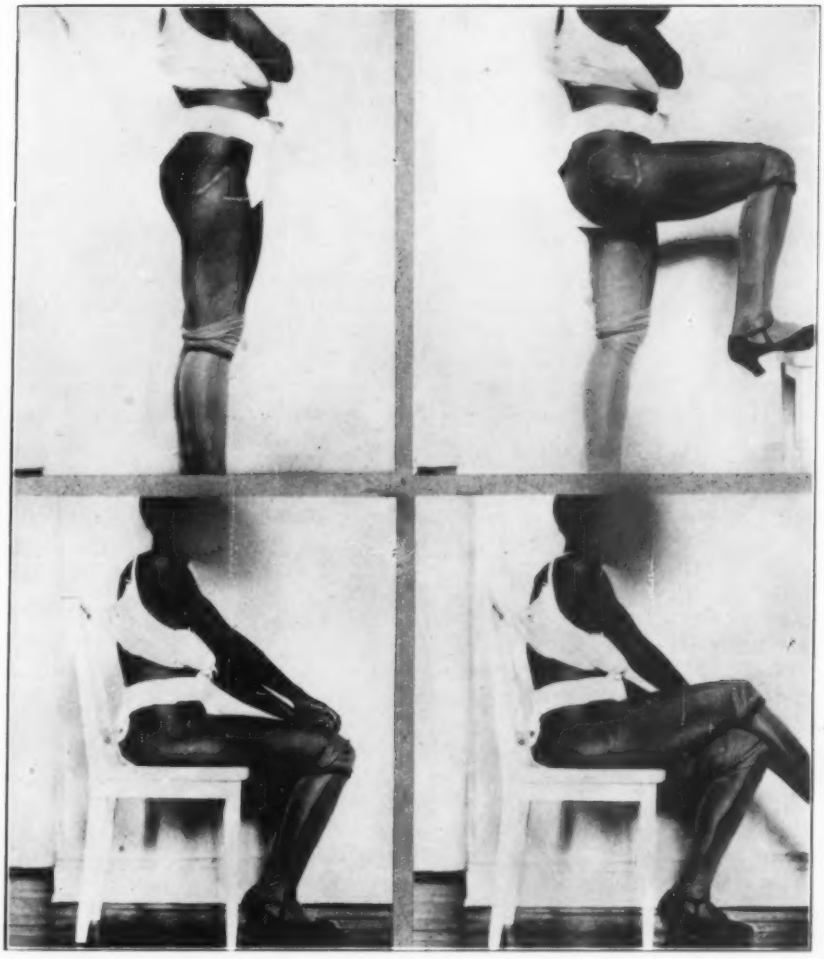


FIG. 33

Case 10-C. Gonorrheal arthritis of the hip, with complete bony ankylosis. Membrane arthroplasty: June 29, 1924. Result almost two years after operation.

HOHMANN, G.: Ueber blutige Gelenkmobilisierung. Munchen Med. Wchnschr. LXIII, 298, 1916.

KIRMISSON, E.: Le traitement curatif des ankyloses par la méthode sanglante. Rev. d'orthop. Paris. 3ème série, V, 247, 1914.

LANGE, F.: Die Mobilisation versteifter Gelenke. Munchen Med. Wchnschr. LXIII, 258, 1916.

LIPPENS: Le traitement sanglant des ankyloses. Progrès méd. belges. Bruxelles. XVI, 3, 1914.

LOVEDAY AND STOUFFS: La mobilisation pneumatique. Note sur une nouvelle méthode de traitement des ankyloses. Arch. méd. belges. Bruxelles. LXXI, 548, 1918.

MACAUSLAND, W. R.: Mobilization of Ankylosed Joints. Imprimerie médicale et scientifique. Brussels. 1923.

MACAUSLAND, W. R.: Ankylosis of Joints; General Pathology, Treatment. Long Island Med. J. XVIII, 285, 1924.

MacAusland, W. R.: Ankylosis; Treatment by Arthroplasty. Boston Med. and Surg. J. CXCI, 716, 1924.

McCurdy, S. L.: Arthroplasty. Penn. Med. J. XVIII, 606, 1914–15.

Magnus, G.: Das Schicksal des interponierten Fettes bei der Arthroplastik. Beitr. z. Klin. Chir. CXXXI, 670, 1924.

Magnuson, P. B. and Coulter, J. S.: Stiff Joints. Internat. Clin. Phila. Series 31, IV, 241, 1921.

Moszkowicz, L.: Ueber arthroplastik. Beitr. z. Klin. Chir. CV., 168, 1917.

Murphy, J. B.: Arthroplasty for Ankylosed Joints. Trans. Am. Surg. Assn. XXXI, 67,1913.

Murphy, J. B.: The Clinical Results of Arthroplasty and Osteoplasty. Trans. 17th Intern. Congress of Med. London, 1913. Sect. VII. Surg. Pt. 2, 69, 1914.

Murphy, J. B.: Arthroplasty. Ann. Surg. LVII, 593, 1913.

Owen, H. R.: Arthroplasty. Ann. Surg. LIX, 426, 1914.

Payr, E.: Weitere Erfahrungen über die Mobilisierung ankylosierter Gelenke. Arch. f. Klin. Chir. Berlin. CVI, 235, 1914–1915.

Payr, E.: Zehn Jahre Arthroplastik. Zentralbl. f. Chir. Leipzig. XLVII, 313, 1920.

Phemister, D. B., and Miller, E. M.: The Method of New Joint Formation in Arthroplasty. An experimental study. Surg. Gyn. Obs. XXVI, 406, 1918.

Prando, D.: Sobre algunas plasticas de cara y artroplastias. Prensa Med. Argentina. Buenos Aires. IV, 399, 1917–18.

Putti, V.: Traitement curatif des ankyloses par la mèthode sanglante. Rev. d'orthop. Paris. 3ème série. V, 281, 1914.

Putti, V.: Arthroplasty. J. Orthop. Surg. III, 421, 1921.

Putti, V.: L'Arthroplastie des articulations ankylosées. Lyon Chir. XIX, 121, 1922.

Ringel: Mobilisation von Gelenkversteifungen durch freie Transplantation von Fettfaszienlappen. Deutsche Med. Wchnschr. Leipzig. XLII, 713, 1916.

Riosalido: De las artroplastias. Med. Ibera. Madrid. XV–XVI, 177, 1921.

Santy, P.: Arthroplasty. Surg. Gyn. Obs. XXXVII, 310, 1923.

Schepelmann, E.: Ziele une Wege der Arthroplastik. Munchen Med. Wchnschr. LXIV, 363, 1917.

Serra, A.: La ricostruzione chirurgica delle articulazioni colpite da anchilosi; lo stato attuale dell'artroplastica. Med. ital. III, 173, 1922.

Sexsmith, G. H.: Bone Grafting and Arthroplasty. J. Med. Soc. New Jersey. XII, 533, Nov. 1915. Also: Med. Record. N. Y. LXXXVIII, 775, 1915.

Sexsmith, G. H.: Arthroplasty: a Safe, Sane and Practical Surgical Procedure. J. Med. Soc. New Jersey. XVII, 333, Oct. 1920.

Simon: Operative Mobilisierung versteifter Gelenke. Berlin Klin. Wchnschr. LI, 235, 1914.

Steindler, A.: Arthroplasty from Clinical and Experimental Standpoint. J. Iowa State Med. Soc. Des Moines. VI, 284, 1916.

Thomson, A.: The sphere of Arthroplasty in the Treatment of Ankylosis. Edin. Med. J. n.s. XIX, 176, 1917.

Todd, A. H.: Arthroplasty. British J. Surg. XI, 319, 1923–24.

Tubby, A. H.: Nearthrosis or Arthroplasty, with Notes of Some Cases. Am. J. Orthop. Surg. XII, 379, 1914–15.

Wheeler, Sir W. I. de Courcy: Reconstruction of Joints. Dublin J. Med. Sciences, including Trans. Royal Acad. Med. of Ireland. 4 s, 433, 1921.

Wieting, J.: Primäre Gelenkplastik bei Tuberkulose. Zentralbl. f. Chir. Leipzig. XLIX, 589, 1922.

Wollenberg, G. A.: Über Gelenkmobilisation. Ztschr. f. Artzl. Fortbild. Jena. XII, 267, 1915.

Wrede: Blutige Gelenkmobilizationen. Deutsche med. Wchnschr. XLII, 1339, 1916.

Zeller, O.: Über plastische Gelenkresektion zur Behebung der Ankylosen. Jahresk. f. artzl. Fortbild. Munchen. X, 12 Heft, 25, Dec. 1919.

REMARKS PREFATORY TO A CINEMATOGRAPHIC PRESENTATION OF LATE RESULTS OF THE RECONSTRUCTION OPERATION*

BY ARMITAGE WHITMAN, M.D., NEW YORK CITY

From the First Division of the Hospital for Ruptured and Crippled, New York

In presenting a paper on the reconstruction operation on the hip, I wish to be particularly careful to avoid any misconception or comparisons that may arise through the fact that the results of the operation are presented in conjunction with papers on the results of arthroplasty. In the majority of cases arthroplastic operations on the hip are operations of convenience. The disability caused solely by stiffness of the hip is, comparatively speaking, so slight as to render the number of patients who seek relief from it small. The operation of arthroplasty is an exceptional one, calling for unusual technical skill. The narrowness of its field lays its results open to severe criticism, so that the operator is likely to be extremely careful in the selection of his cases. An ankylosed hip in favorable position causes so little disability that an attempt to improve upon it seems almost a luxury to the patient and the surgeon.

The patients upon whom the reconstruction operation has been performed represent an utterly different class. They are for the most part working men and women, hospital patients. They had tried almost every remedy and would have been content to put up with any amount of pain or disability that would have allowed them to do their necessary daily work. No one wishes to be operated on, and these patients came to operation as a last resort. Therefore, as contrasted to that of arthroplasty, it may properly be classed as an operation of necessity rather than one of election.

At the Hospital for the Ruptured and Crippled during the last six years, the operation has been performed for a variety of ailments, but the present paper is confined to a discussion of the two major conditions to which it has been applied, — ununited fracture of the neck of the femur, and arthritis deformans.

The first pathological condition for which it is performed, ununited fracture of the neck of the femur, scarcely calls for comment. For the most part it is one occurring in patients of middle or advanced age, not favorable surgical subjects. They suffer from pain and disability. The results they crave in their order of importance are (1) relief of pain, (2) stability, (3) mobility. We feel that these results may be promised with a high percentage of certainty. The reason that we practise the operation

*Read before the American Orthopaedic Association at Atlanta, April 27, 1926.

instead of bone grafting — practically the only alternative — is that a bone graft, while it might in selected cases give a slightly better result if successful, depends for its success on the reparative powers of the patient himself. This reparative power cannot in any case be predicted with certainty, but in this class of cases may be predicted with almost absolute certainty to be low. Also, in those cases in which the neck of the femur has been absorbed, the reconstruction operation offers a better result than might be anticipated from the most successful bone graft.

In the case of arthritis deformans the patients also seek relief from pain and disability and the results sought are the same. The performance of the operation is based upon the pathology of the disease. This is primarily a destructive process affecting the cartilage covering the head of the femur. As the disease progresses it affects the cartilage lining the acetabulum and gives rise to marginal hypertrophy and proliferations about the joint. The friction between the diseased and normal surfaces, or the diseased surfaces, as the case may be, causes pain, which in turn gives rise to protective muscle spasm and consequent deformity. The mechanical effect of the friction is also powerful in hastening the destruction of the softened, spongy, diseased portion of the underlying bone.

The operation, therefore, aims first, by removing the cartilage of the head of the femur and paring down the head until it is about the size of the neck, at removal of the primary source of irritation. This reduction in the size of the head removes or lessens friction, the greatest cause of pain. It had been observed that the results of arthrodesis operations upon the hip were unsatisfactory, in that, by any method, complete ankylosis was obtained in only about fifty per cent. of cases, that what motion there was was painful, that deformity recurred and that the deformity was that most disabling one of flexion and adduction. The last feature of the reconstruction operation, the transplantation of the trochanter downward upon the shaft of the femur, was designed to provide sufficient leverage to guard against this deformity. Having observed the difficulty of obtaining ankylosis when ankylosis was the primary desideratum, it was recognized that postoperative motion was probable in any case. It was felt that the removal of the cartilage was likely to make this motion less painful and in some cases even serviceable to the patient.

Dr. Whitman describes the operation as follows [1]: "The incision, in the shape of a half U, begins an inch below and behind the anterior superior spine and crosses the femur at a point about three inches below the apex of the trochanter. The deep fascia is dissected backward and the interval between the tensor vaginae femoris and gluteus medius opened, exposing the capsule. With a wide chisel the base of the trochanter is then separated from the shaft in the line of the neck and with its attached muscles is turned upward. The capsule is opened and with a large curved chisel the greater part of the head is removed, the design being to include all the cartilage, the marginal exostoses and as much of the underlying bone as may be involved in the degenerative process, including in some instances a part and

in others, all of the femoral head. This articulating extremity is made round and smooth with a chisel and file, and is then inserted into the acetabulum, the cartilage of which, except on the outer and superior margin, is usually fairly normal. And since in the abducted attitude there is little direct contact between the two, there would seem to be no necessity for covering the neck with fascia, although this has been done in some instances in which the bone seemed particularly soft. A thin section of bone with the overlying muscle in the form of a flap, is turned back from the upper and outer surface of the shaft and the limb having been abducted sufficiently, the trochanter is brought down so that its base may be apposed to the bare surface on the outer part of the shaft, where it is fixed by deep sutures through the overlying tissues or by a bone screw. The wound is closed in layers and a long plaster spica is applied in the extended and abducted attitude. This remains for several weeks in order to assure the fixation of the trochanter in its new position. The after-treatment will vary according to the circumstances of the patient. If early locomotion is desired, as in the cases in which the hospital expense is a burden, a short spica extending only to the knee holding the limb in about 20° of abduction is applied and the patient is discharged on crutches, weight-bearing being permitted if it causes but little discomfort. In cases which remain under supervision the limb is usually suspended from a frame by pulleys, and passive and later voluntary movements are begun, regulated by the degree of discomfort. The most important factor in the after-treatment is persistent methodical stretching of the limb outward to the proper degree of abduction and backward to complete extension, thus checking the tendency toward the former attitude of flexion and adduction and resulting compensatory shortening of the limb."

Between the years 1916 and 1924 there were performed at the Hospital for Ruptured and Crippled on both divisions forty reconstruction operations for the relief of arthritis deformans and ununited fracture of the neck of the femur. Since 1924 approximately an equal number have been done. Of these forty cases, two died in the hospital approximately two weeks after operation, probably from pulmonary embolism. Of the remaining thirty-eight, twelve cases reported, three of whom came either during my absence or before the arrival of the motion picture camera and thus have not been shown. Seven reported by letter that they were not only satisfied but were enthusiastic over their result. They lived at such distances, however, — Chicago and St. Louis for example — that they found it impossible to return. Nineteen letters were returned to the hospital.

The nine cases whose cinematographic records you will see may be averaged as follows:

For ununited fracture four cases. The average age of the patient was fifty-nine years,—the duration of the patients' symptoms ten and one-half months, the average time elapsed since operation four years and three months. They average 44° of flexion, 10° of abduction and one inch of shortening.

Case 1-A

Case 1-B

Case 1-C

Case 1. Mrs. M. G., age 68 years, left hip. Ununited fracture. 8 months duration. Suffered from pain, instability and inability to walk. Operated upon Oct. 6, 1916. Patient is in excellent condition, walks with a slight limp, uses a cane on the street, no apparatus in the house. Has earned her living as a seamstress since her discharge from the hospital. Is in every way satisfied with the result. A.G.E.* 180°. A.G.F.† 110°. Abduction 10°. Shortening 1 in.

*Angle of greatest extension. †Angle of greatest flexion.

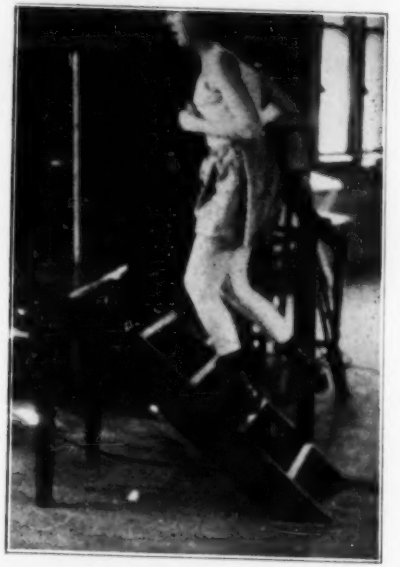
CASE 2-A

CASE 2. B. W., age 60 years, left hip. Intracapsular fracture—2 months before. Was in bed completely helpless, could not sleep from pain. Operated upon July 7, 1924. She is now in good condition. Uses one crutch on the street, but can do without it in the house. A.G.E. 180°. A.G.F. 170°. Abduction 10°. Shortening 1 in.

CASE 2-B

CASE 3-A

CASE 3-B

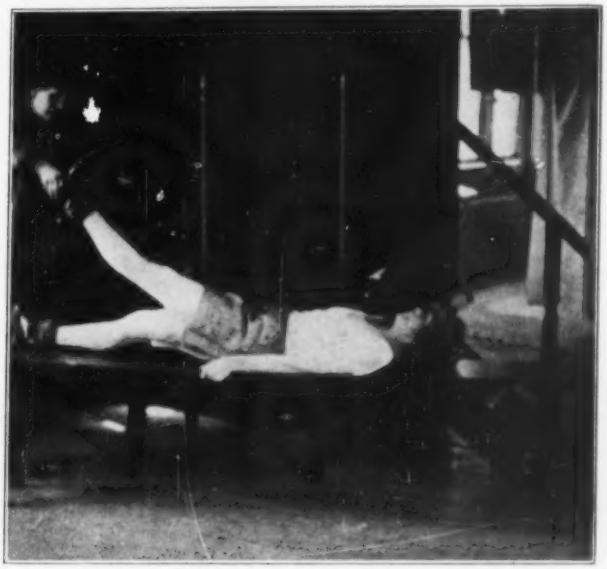


CASE 3-C

CASE 3. M.D., age 65 years, right hip. Arthritis deformans. Duration 1 year. Patient was practically crippled, barely able to walk with one crutch. Operation April 14, 1924. She is now much improved. Pain is less. A.G.E. 180°. A.G.F. 160°. Abduction 5°.

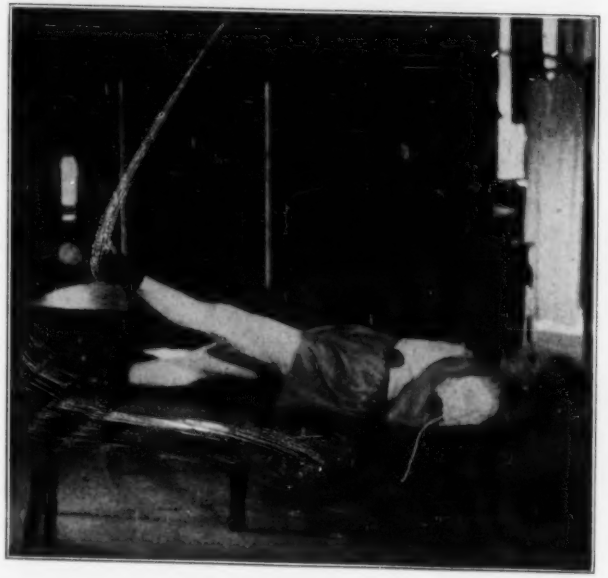
CASE 4-A

CASE 4. Mrs. J. McC., age 52 years, left hip. Arthritis deformans. Duration 10 years. Operated upon Nov. 2, 1923. Patient is in good condition. Walks without apparatus, does her own work. Has some pain of the rheumatic type when the weather changes. A.G.E. 180°. A.G.F. 130°. Abduction 15°. Shortening ½ in.



CASE 4-B

CASE 5-A



CASE 5-B

CASE 5-C

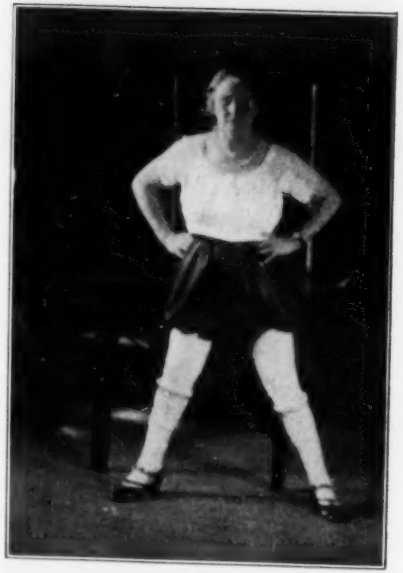
CASE 5. Mrs. M. H., age 54 years, right hip. Fracture neck of femur. 8 months duration. Was operated upon March 29, 1923. Is now in excellent condition. Uses a cane on the street but not in the house. Does all her own housework. Has practically no pain. A.G.E. 180°. A.G.F. 150°. Abduction 10°. Shortening 1 in.

CASE 6-A

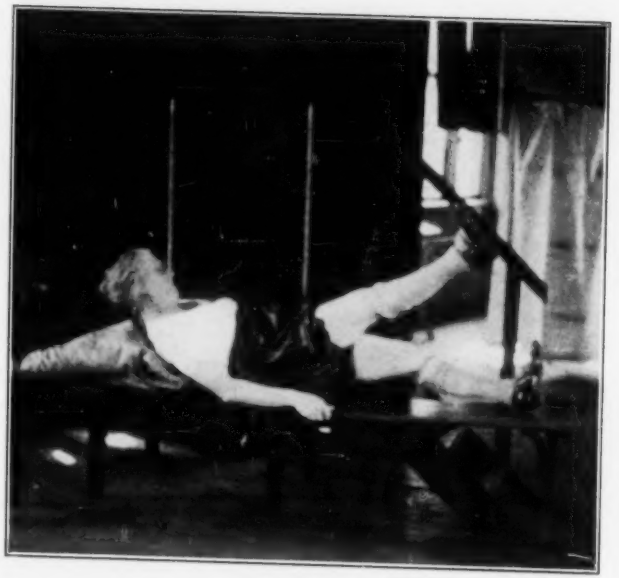
CASE 6-B

CASE 6-C

CASE 6. J. B., age 50 years, right hip. Arthritis deformans. Duration 2 years. Practically complete ankylosis, constant pain. Operation May 12, 1924. Now walks with a cane on the street only. Does all her own work. A.G.E. 180°. A.G.F. 170°. Abduction 10°. Shortening ¾ in.



CASE 7-A



CASE 7-B

CASE 7-C

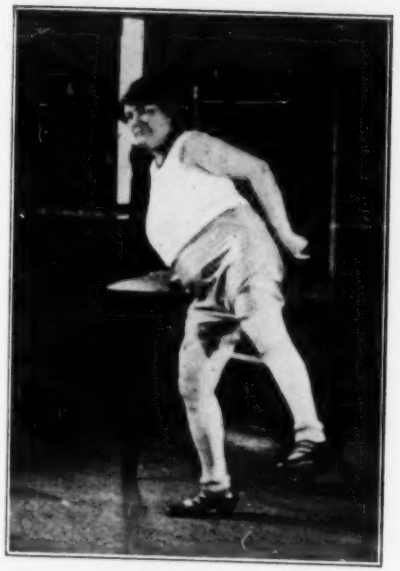
CASE 7. Mrs. C. T., age 50 years, right hip. Ununited fracture. 2 years duration. Practically completely incapacitated. Operated upon March 1921. A.G.E. 180°. A.G.F. 135°. Abduction 10°.

CASE 8-A

CASE 8-B

CASE 8-C

CASE 8. S.S., age 48 years, left hip. Arthritis deformans. Duration 6 years. Continuous pain, deformed and disabled. Operation July 28, 1924. She now, even weighing 214 lbs., walks without any apparatus, has practically no pain and an almost complete range of motion. She does all her own work. A.G.E. 180°. A.G.F. 90°. Abduction 15°. Shortening 1 in.



CASE 9-A

CASE 9-B

CASE 9-C

CASE 9. Mrs. J. C., age 45 years, left hip. Arthritis deformans, secondary to malunion of fracture of the neck of the femur. Duration 13 years. Operated upon Nov. 15, 1924. The patient is in excellent condition, except for weighing 180 lbs. She does all her own work. Uses a cane upon the street. Has occasional discomfort in the hip. Is well satisfied. A.G.E. 180°. A.G.F. 120°. Abduction 10°. Shortening 1 in.

For arthritis deformans five cases. The average age of the patients at present is fifty-two years. The duration of their symptoms before operation was six years plus. The average time elapsed since operation is two years and three months. They averaged 46° of flexion, 11° of abduction and .55 of an inch of shortening.

Of the two classes combined, all but one patient — the one shown using a crutch — have returned to their normal household activities. Impressions as to the improvement in regard to relief of pain can be little more than impressions, but you may judge by the faces of the patients themselves, which are not those of chronic sufferers. The most pessimistic of the cases of arthritis deformans when pressed as to an estimate of the difference in the amount of her pain admitted it to be at least fifty per cent. improved.

We feel, therefore, that for ununited fracture of the neck of the femur the reconstruction operation fulfills the requirements for which it was designed.

When performed for arthritis deformans, we feel that we may predict a sufficient relief of pain to justify the risk of the operation, and promise a stable hip. The progress of the disease, as dependent on friction of diseased surfaces, has been arrested. In certain cases sufficient motion has been retained to make the results compare favorably with the most brilliant arthroplasty. When ankylosis has resulted adduction deformity has been prevented. Naturally in both classes of cases the prognosis must vary according to the age, occupation and weight of the patient, and most particularly in regard to the opportunities for postoperative supervision and after-care.

REFERENCE

1. Whitman, Royal: The Reconstruction Operation for Arthritis Deformans of the Hip Joint. Ann. Surg. LXXX, 779–785, 1924.

71 PARK AVENUE

NEW YORK CITY

DISCUSSION

Note: The paper of Dr. Willis C. Campbell, to which reference is made in the following discussion, will appear in a later issue of the *Journal*.—*Editor*.

Dr. A. H. Freiberg, Cincinnati, O.: The thing which has struck me in the matter of arthroplasty is that we are dealing with a subject characterized by its variability as regards the results obtained by different men as well as by the results in different joints. In this regard it differs from most of the other surgical operative work we have to do. We are accustomed to find, after a certain number of years of experience with a given operation, that it conforms to certain standards and that one well-trained man can do what another well-trained man can do. We find, on the other hand, that one man gets better results in the hip and another in the knee with arthroplasties. For a long time I have felt that we were on the wrong track. I have felt for some years that the interposition of tissue had little or nothing to do with the case and that is my opinion at the present day. It has seemed to me that if we can obtain movable joints after operations for joint tuberculosis, as we have done even without resecting excessive amounts of bone, we should be able to do the same thing in ankylosis where tuberculosis has not been present. We can do this in the elbow, I am sure. It seems to me that we should

be able to do it in the hip. I am going to show two slides of a young man who had two hips ankylosed from a septic arthritis. In his case I undertook operatively to produce a disproportion between the size of the acetabulum and the size of the femur and without the interposition of tissue. The first slide will show the hips before operation, both sides ankylosed by bone. The next slide shows the hips as they are at the present day. The first hip was operated on in June 1924. After the first operation I felt that I had improved the position of the hip, but motion was gradually lost and I concluded that the operation was a failure because I had not gone far enough. In January 1925, I did the same thing on the other hip. This man is now able to flex his hip to 90 degrees and is able to abduct and adduct. He has no rotation motion at all. He considers himself enormously improved and furthermore he is obtaining more motion as time goes on instead of losing it.

Dr. F. H. Albee, New York, N. Y.: I was interested to note that in the reconstruction they approached the hip by turning up the trochanter. I have in all my operations approached the hip by the Smith-Petersen approach. They say there is a great scar formed by the Smith-Petersen incision, but I have not found that to be so in the cases I have done.

As to Dr. Baer's warning that there is danger of hernia when you remove a large amount of fascia and fascia lata, I have not found that to be the case. I have had no hernia. I have removed large amounts of fascia lata and have had no trouble.

I have several slides which show the operation which I began to do ten years ago. I would like to show these so that Dr. Whitman can in the future demonstrate my operation correctly. First, the end of the neck and the trochanter have been shaped up as in an arthroplasty. The next slide shows what happens when the leg comes to the midline. One of the objects of the bone lever which I use is to restore the abduction or active abduction that has been lost when the neck of the femur was destroyed. Of course, the neck of the femur is the lever by which the musculature is able to produce active abduction. The second object is to prevent a possible dislocation in such cases, because, when the neck is entirely eroded and gone in these cases of ununited fracture, there is really danger of dislocation. With the leg at the midline and this lever in position we have directed the head into the acetabulum.

As to my practice of using a bone graft on the neck of the femur, at the present time I use a bone graft in only 5 per cent. of my cases, and in 95 per cent. of the cases I am doing this operation which I have shown on the slides. This operation has a place in arthroplasty. As far as doing a reconstruction operation *per se* for arthritis deformans and as a substitute for arthroplasty, I have not looked at it in that light. I have a case apropos of that referred by Dr. Crile of Cleveland. An arthroplasty had been done on both hips. So much bone had been removed that the hip partially dislocated every time the leg came to the midline. The woman said she would rather have a stiff hip than this recurring dislocation. In this particular case I proved the advantages of this lever, in that I went in without disturbing this arthroplasty and merely turned out the lever as shown in the next slide. The mere turning out of this lever absolutely overcame the unfortunate result of the arthroplasty and the hip has never dislocated since.

Dr. A. Bruce Gill, Philadelphia, Pa.: Dr. Baer's large experience, the accuracy of his work, and his clear and splendid presentation give us very definite facts and principles which we cannot controvert. He has added much to our knowledge of arthroplasty of the hip.

There are several things in connection with this subject to which I should like to call attention. In Dr. Baer's patients whom he has shown on the screen, any persistent postoperative limp, disability, and deformity has appeared to be due largely to adduction of the thigh. If better abduction could be secured at the time of operation or by postoperative management, I think the amount of limp and disability would be reduced.

In the second place, there are certain cases of old quiescent tuberculosis of the hip which I think can be improved by operation on the hip joint. In fact, some of them practically demand operation for two reasons: severe flexion and adduction deformity,

and pain. In such cases one finds usually that the head and neck of the femur have been destroyed, that the femur is displaced upward and backward, and that it is fastened to the side of the pelvis by scar tissue. The acetabulum has either been eroded or it is filled up with débris and scar tissue. Marked flexion and adduction deformity is usually present. There is disabling shortening of the extremity. The hip is unstable and insecure. As the patient grows older and heavier, and as he becomes more active in trying to earn a livelihood, he frequently suffers from pain, more or less constant, or intermittent, which prevents him from working.

Cases of tuberculosis of the hip, in which the head of the femur lies in the acetabulum and in which there is little or slight deformity, may be allowed to remain, or the moderate deformity may be corrected by a subtrochanteric osteotomy. But the severe type described above cannot be improved or cured by such osteotomy because the marked deformity cannot be thus corrected and because the connection between the femur and the pelvis still remains insecure and painful. We must do an operation on the hip joint itself.

In this operation we may attempt either an arthrodesis or an arthroplasty. The débris and scar tissue should be cleaned out of the acetabulum until we come down upon the old cartilage which lines it. The upper end of the femur may then be shaped up by removing the trochanter which is later placed in contact with the shaft of the femur a little lower down. This reconstructed head may then be put in the acetabulum with the thigh moderately abducted. We thus overcome the deformity and secure a solid weight-bearing hip. If we desire to do an arthrodesis, the acetabulum must be denuded of all cartilage. If we desire motion in the hip, we may secure it by placing a soft tissue flap in the usual manner or by having the reconstructed head in contact with the articular cartilage of the acetabulum. It is admitted by all that if bony union is secured there is but little likelihood for a recrudescence of the disease. If healing occurs with motion in the hip, there is a possibility of such a relighting of the disease. Personally I believe that this danger has been exaggerated. In a certain percentage of tuberculous hips in which operation is never done, the disease becomes active in later years. An operation which removes the old débris and scar tissue from about the hip joint probably makes the hip less apt to be the site of future disease than if it is left alone, because certain potential foci are thus removed. If there has been tuberculosis of both hips with consequent deformity and disability, we must attempt motion in one at least. If we find from our experience that we are able by improved modern methods of technique and by proper after-care to secure such stability with mobility without a relighting of the disease, then eventually we may come to select the arthroplasty as the method of choice rather than arthrodesis.

In the third place, I wish to point out that following arthroplasties of the hip, when there is flexion or adduction deformity and insufficient mobility, these conditions may be due to contractures in the soft tissues about the joint and not due to any fault of our plastic work on the bones at the time of operation.

Dr. Robert B. Osgood, Boston, Mass.: In what proportion of cases has Dr. Baer or Dr. Campbell found definite evidence that these cases supposed to be tuberculosis before operation were tuberculosis?

Dr. Leo Mayer, New York, N. Y.: What is the earliest age at which arthroplasty was performed in these cases? What would Dr. Baer advise doing in a case of bilateral hip ankylosis in a child of six, the ankylosis having been produced by a pyemic infection of the hip joint?

Dr. Brainerd Whitbeck, New York, N. Y.: In a rather extensive service with tuberculosis of the various joints, I feel if a hip joint recovers with ankylosis it is a very satisfactory condition. I do not agree with Dr. Gill as to the advantage of a unilateral osteotomy.

In regard to the cases Dr. Whitman showed, one of those cases was one on which I operated about two years ago. The woman weighed 215 pounds and had for several years been very greatly disabled. She came into the hospital, walking on crutches, with

a limited amount of abduction and flexion, complaining of inability to do any housework because of the pain. In the x-ray the head of the bone appeared to be a very large mushroom head, considerably larger than the acetabulum. Examination of the patient showed a marked limitation of motion and pain on motion. Operation showed a very large mushroom head. I operated in very much the same manner as Dr. Campbell showed in his animated cartoon. I took particular pains to make the head somewhat smaller than the acetabulum because I felt there would be probably no opportunity for ankylosis to take place as it would if the head accurately fitted the acetabulum. The cartilage was left free on the end of the head. The result was as you see in the pictures. The woman after two years has no pain whatsoever and does all her housework. She still weighs some 215 pounds and has 180 degrees extension, 90 degrees flexion and practically a normal range of abduction.

Dr. Whitman has so often called attention to the importance of abduction. Unless we can obtain a nearly full range of abduction there will always be a limp. The limp in most of these cases, in my opinion, is due to adduction.

Following the removal of the plaster, abduction should be preserved by careful attention to the manipulation of the hip. The attention of the patient should be called to the importance of this manipulation and in this way I believe the abduction can be maintained.

Dr. Walter Truslow, Brooklyn, N. Y.: There are two points to be considered. One is the indication for arthroplasty of the hip. With me, only the presence of ankylosis, with severe deformity, has been sufficient reason for operating. I believe the good motion resulting has been due to the fact that plaster-of-Paris was applied with the particular thought in view that the deformities of adduction and flexion should be overcome; and therefore the limb was put up in extreme abduction and extreme extension.

The other point I wish to discuss is the question of tuberculosis of the joint. In view of the significance of Dr. Osgood's question, the first three cases I operated on I believe were tuberculosis, but the belief was based only on clinical findings. I think the results warranted doing the operation in young adults.

Dr. J. T. Watkins, San Francisco, Calif.: I want to support Dr. Freiberg's contention. Some years ago I had a hip which I treated as he outlined. Dr. Albee told me I could not do it again without getting pain. Such a case came and I tried it, but did not succeed, so I sent it to Dr. Baer who operated on it.

Dr. C. W. Peabody, Detroit, Mich.: Even though the time is short, I feel that Dr. Whitman's paper deserves more recognition than it has received. Our experience with it has seemed to indicate that its merits do not depend on the high technical skill of its author, inasmuch as the half-dozen cases in our series have averaged as good or better range of motion than those in Dr. Whitman's series, although not better than the case reported by Dr. Whitbeck.

We have carried out a slight modification in removing the capital fragment only, without remodelling the stump of the neck; instead, attempting to preserve the limiting membrane of fibrocartilage, which we have uniformly found to be present at the site of fracture, and to be part of a true pseudarthrosis which had developed there with the capsule and serous fluid. After removing the head and transplanting the trochanter, we have simply pushed up the stump of the neck in the acetabulum, retaining this part of the pseudarthrosis. The thing does not look as well in the x-ray picture, but it seems to allow for an early and considerable range of motion.

Dr. W. S. Baer, Baltimore, Md. (closing his part of the discussion): In regard to Dr. Freiberg's question, the fact that these results are variable in the hands of different men is very true. I think we are going through a stage of finding out. Many cases that were operated on first were operated on experimentally and we have learned a great deal as to what cases to operate on and as to what cases not to operate on. I think we might definitely say, and in fact Putti and many others do say, that ankylosis is cured if we interpose certain tissues. Three cases of non-interposition, simply resection, which I have had, came to me (one operated on by a member of our own

Society, two operated on by surgeons of great note in this country) without any interposition and they recurred. I interposed membrane in all cases. I think fascia probably does the same thing. If any one can prove that the results are as good with fascia, I might probably go over to the use of fascia.

There are two schools also in regard to the formation of joints. One is that it is formed by the connective tissue lying on top of the bone, and the other that there are cartilaginous cells that will grow in the bone cells.

In the tuberculosis cases, I think there are certain cases on which I would operate. As a rule I would not operate if the tuberculosis is in a stiff hip, in a perfectly good position with no deformity. Why change it? Why run the risk of setting up a tuberculosis? But tuberculosis rarely ever gets stiff. The pathologic process in tuberculosis prevents it from getting stiff and hence you get the deformity. The pathologic process of tuberculosis leaves a cartilaginous area always. Tuberculosis always leaves the cartilage behind it and then comes the power of the adductor muscles with the irritation of the cartilage and you get your marked deformities. In cases that have gone on for a long time where we suspect that the tuberculosis is absent, examination of the tissue removed frequently shows an old tuberculosis, as found in ten of our cases. In old chronic tuberculosis in older people who have marked deformity and recurrence, osteotomy does no good. Osteotomy will never do any good unless there is absolute fixation and fixation as a rule is not there.

I am glad to hear that Dr. Albee has come over to arthroplasty in osteo-arthritis. When I first presented the possibility of doing a resection in osteo-arthritis in 1913, Dr. Albee insisted on arthrodesis. In the hypertrophic type I believe with Dr. Whitman that operation gives very good results. I have had four patients come back insisting on another operation on the other hip. No need for arthroplasty there; motion will always be present on account of the presence of the old cartilage in the socket itself, which has not been destroyed.

In regard to what I would do with a double infection in a child, I would be absolutely sure that the infection was over and I would be absolutely sure there was nothing the matter with the liver or kidney. I think it is wrong as a rule to operate on children. I think arthroplasty ought to save the epiphyseal line if it can. I think any operation on a child during the growing stage should be avoided. Then when growth has ceased I would do an arthroplasty on the hips, providing there was no contraindication.

Dr. Willis C. Campbell, Memphis, Tenn. (closing his part of the discussion): In my early work in this field, I thought possibly, as Dr. Freiberg has stated, that the rôle played by the interposition of tissue was negligible, but after considerable experience with and without the interposition of tissue, I am convinced that some material should be interposed between the raw bony surfaces. It is a well-known fact that soft tissues may induce non-union of fractures, therefore it may be presumed that a similar effect might be caused in the restoration of a new joint.

In answer to Dr. Mayer: Arthroplasty should not be entertained until all evidence of active infection has subsided and the bone structure has returned to normal in the extremity.

Arthroplasties are contraindicated in children, as the operative procedure often involves the epiphyses. Further, children do not co-operate in the restoration of function, so necessary to a successful result.

Dr. Armitage Whitman, New York, N. Y. (closing his part of the discussion): I should be very sorry to inject any note of controversy into this pleasant morning, particularly as the controversy is not my own. The question of priority in regard to the reconstruction operation is one that must be settled between Dr. Albee and my father.

In taking issue with Dr. Albee upon any question, I always feel somewhat like David. If I may be allowed to substitute for a smooth, round stone a piece of chalk, I think I can explain upon the blackboard the essential differences between the operation which Dr. Albee has just illustrated by his lantern slide and the reconstruction operation. (Dr. Whitman thereupon drew diagrams illustrating the two operations.)

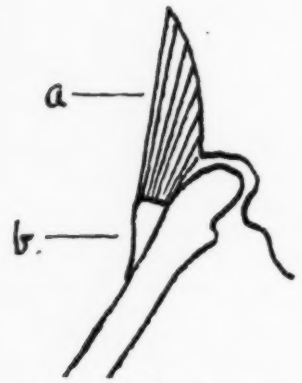


FIG. 1

The Reconstruction Operation. a. Abductor muscles under tension; b. Trochanter displaced downward upon the shaft of the femur to maintain 15° abduction.

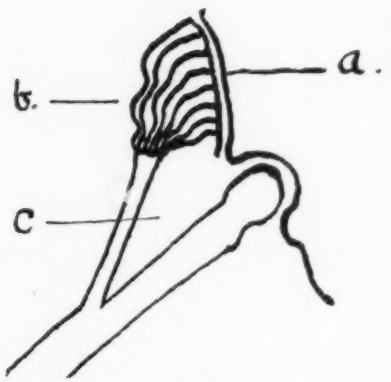


FIG. 2

The Albee Operation. a. Abductor muscles separated from their origin by the Smith-Petersen incision. b. Abductor muscles entirely relaxed. c. Wide gap later to be filled in by bone.

This represents the reconstruction operation. We abduct the limb at least ten and preferably fifteen degrees. We then transplant the trochanter with its attached muscles as far down upon the shaft of the femur as the length of the abductor muscles will permit. Following the union of the trochanter to the shaft the abductor muscles thereby maintain this degree of abduction — a degree which we consider essential to success.

Dr. Albee's diagram shows the limb in a position of very wide abduction, the trochanter split away from the shaft of the femur and the abductor muscles consequently, far from being under tension, completely relaxed.

Furthermore, it would appear that Dr. Albee was inclined to disregard the importance of the abductor muscles, inasmuch as he performs the operation by the Smith-Petersen incision. This incision, as we all know, separates the abductor muscles from their point of origin and thus deprives them of any possible sling action.

With the limb in the position Dr. Albee illustrates it would be necessary to bring the limb into the midline before any tension on the abductor muscles could be established. Were such a degree of adduction permissible following the reconstruction operation we should consider the result unfortunate.

Dr. Albee speaks of the wide space between the split-away trochanter and the shaft of the femur—the space indicated in the diagram by the letter C—so filling in with bone as to establish a new neck of the femur. I think that is a very ingenious idea, but I never read of it in Dr. Albee's published articles upon the subject, nor did I ever hear it mentioned before this morning. I should be interested to know how this wide gap is maintained during the somewhat lengthy period that must elapse between its creation and its filling in. By the appearance in the diagram one might suppose there would be a strong tendency for the unsupported trochanteric fragment to fall back into apposition with the femur.

PAINFUL EXOSTOSIS OF LITTLE TOE: AN OPERATION FOR ITS RELIEF

BY FREDERICK CHRISTOPHER, M.D., F.A.C.S., EVANSTON, ILLINOIS

Associate in Surgery, University of Illinois Medical School, Junior Surgeon, Evanston Hospital

Persistent corns of the little toe may in reality be due to an underlying phalangeal exostosis. It seems probable that such exostoses are a response to the chronic irritation of a tight shoe. In the presence of an exostosis, however, the toe remains painful and the corn persists even if the shoes have been corrected. The following case report illustrates such a condition and suggests for the cure an operation no mention of which was found in the literature.

Mrs. M.C.L., age 33, had suffered from a painful left little toe for nearly six years. On the outer side of the toe was a corn which had always been the center of the painful area. She had been the rounds of chiropodists who had subjected her to varying treatments including painting with silver nitrate once weekly for six months. On the advice of a physician she had worn a loose shoe for a year. Hot soakings and various corn remedies were tried. All of these measures were fruitless, however, and the patient became very much discouraged because the continual pain in her toe debarred her from practically all of her activities.

When first seen by the writer, conservative treatment of avoidance of pressure, trimming of the corn, etc., was advised and carried out. At the end of six weeks, there being no improvement, an x-ray was taken (Fig. 1). This showed the lateral margin of the distal end of the fifth proximal phalanx to be larger on the affected side than on the side in which there was no pain (the right).

On May 10, 1926, under general anaesthesia, a curved incision, running longitudinally on the outer side of the toe, was made. The soft tissues were retracted and the bony protuberance removed by a rongeur so that a smooth flat surface resulted (Fig. 3). The extensor tendon was severed. The skin was closed by a few silk sutures. The wound healed cleanly and the convalescence was rapid and painless. Four weeks after the operation the patient was able to wear her shoe and was free from pain.

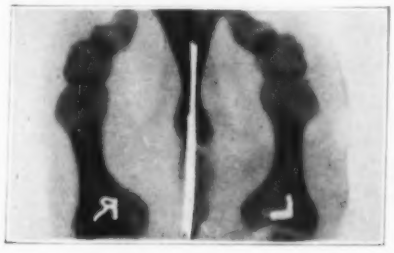


FIG. 1

FIG. 2

FIG. 3

Fig. 1. X-ray of right and left little toes (the left toe is shown on the right, the right at the left) showing exostosis on lateral side of distal end of proximal phalanx.
Fig. 2. Bones of normal toe.
Fig. 3. Line AB shows area of bone removed.

CONGENITAL DISLOCATION OF THE KNEE JOINT

BY C. H. BALDWIN, M.D., UTICA, N. Y.

While dislocation is rated as one of the most common of the congenital abnormalities, congenital dislocation of the knee joint is none the less a rare condition. Like all other congenital dislocations, if treated early, results are quite satisfactory. Whereas if treatment is delayed, the method of procedure becomes more complicated, due to changes in the bone and soft tissues, and the results of treatment are more uncertain. The following case is reported as it demonstrates the ease of treatment in early infancy and shows as an end result a joint anatomically and functionally normal.

An infant normal in every respect, except for a deformity of the left knee, was seen the second day after birth. The knee was held in a position of extreme hyperextension. There were numerous folds on the anterior surface. The leg could be hyperextended so that the toes could be placed in contact with the chest. It could not be extended quite to a straight line. No patella could be palpated. X-ray showed an anterior dislocation of the tibia on the femur. Ten days later under light anaesthesia the dislocation

FIG. 1

Radiograph on second day after birth. Lateral view. A-Anterior surface, C-Epiphysis of femur.

FIG. 2

Radiograph at eight and one-half years of age. Lateral view.

was reduced. Reduction was accomplished with little force. There was a distinct click felt as the femur slipped forward. The knee could then be flexed to nearly its normal limit. It was held in a position of about ninety degrees flexion on a plaster splint. There was a moderate reaction which lasted about one week. The splint was removed daily after the first few days for the purpose of cleanliness, but the knee was not allowed to extend. At the end of four weeks flexion was normal and extension was normal with no tendency towards recurrent dislocation. However, as a safeguard a brace which permitted flexion but limited extension to within forty-five degrees was used until the child was six months old. It could have been discarded safely at a much earlier period. At the present time, eight and one-half years after treatment, the knee presents no difference either functionally or anatomically from that of the opposite side. Never, from the time the child began to walk, has it given any trouble.

Absence of the patella is reported as being frequently observed in connection with this deformity. In this instance, at birth no patella could be palpated. In the normal knee the patella is palpable at birth. At the present time, the patella is normal both in size and contour. It would seem that this frequent absence of the patella may be most easily explained by Wolff's law. Normal joint friction at the point where the patella is to develop is absent as long as the tendon of the quadriceps is not stretched over the lower end of the femur. Until this occurs there is no mechanical need of a sesamoid bone at that point. Therefore it remains in a rudimentary state. If these cases could be corrected shortly after birth it is reasonable to suppose that a patella would develop in practically every instance.

AN ANALYSIS OF ONE HUNDRED X-RAYS OF PATELLAE IN CHILDREN BETWEEN THE AGES OF TWO AND ONE-HALF AND SIX YEARS WITH ESPECIAL REFERENCE TO THE CENTER OF OSSIFICATION AND A REPORT OF ONE CASE OF DELAYED OSSIFICATION OF THE PATELLAE*

BY A. R. SHANDS, JR., M.D., BALTIMORE, MD.

Children's Hospital School

A review of the literature on the subject of the ossification of the patella and the appearance of the center or centers of ossification has revealed little. It is because of the scarcity of information on the subject that this study of the x-rays of knees in children between the ages of two and one-half and six years has been made.

In 1898 Thorndike reported a study of the literature on the congenital absence or tardy development of the patella. In a series of fifty-one cases, the majority, being children under two years, showed no patella, but these probably showed one later on. There were found nine cases in which the patella appeared at ages from six months to six years.

In 1902 Joachimsthal described an abnormal bony point limited to the apex of the patella which he has shown remained there, distinct from the patella, to adult age. In 1883 Wenzel Gruber, at autopsy of a patient aged twenty-one, demonstrated one small piece of bone attached to the superior external angle of the patella by fibrous tissue.

In 1921 Mouchet reported a case of a boy aged fourteen, who fell and struck his right knee. The x-ray showed a questionable fracture of the patella. An x-ray of the left knee, which had not been injured, showed the same fracture. He believes that there was an anomaly of the ossification of the patellae in this case. In the same article Mouchet refers to Sappey, who states that the center of ossification of the patella appears at two years, to Curveillier as stating that it appears at two and one-half years, and to Rambaud and Renault who place the age at almost five years. The latter two authors believe that the ossification appears from a series of granules. It is stated that complete ossification does not occur until the fourteenth year, that it may be delayed until the twentieth year, and that there may be two centers of ossification.

In 1921 Todd, Wingate and McCally, in an exhaustive article on anomalies of the patella, report, from work done on the cadaver, that the patella may be divided into one or more separate pieces of bone along the borders. In 1925 Adams and Leonard reported six cases of congenital anomalies of the patella, in which this had been observed. In four of these a diagnosis had been made of fracture. Five of the six cases showed a

*From the Orthopaedic Department of Johns Hopkins Hospital.

bilateral condition. In these cases the outer and upper quadrant of the patella was always involved.

In Piersol's Anatomy, 1907, it is stated that the ossification of the patella begins by the deposit of several granules some time between the second and fifth years. The granules unite into a central mass from which the ossification spreads to the deeper parts, the bone being not fully formed until puberty, or possibly not before the eighteenth year. In Gray's Anatomy, Lewis Edition 1924, it is said that the ossification center makes its appearance in the second or third year, but may be delayed until the sixth year, and is completed at the age of puberty. There may be two centers side by side. In Gray's Anatomy, DaCosta and Spitska Edition 1908, it is stated that, according to Beclard, a single center of ossification appears about the third year, but that Mr. Pick has seen in two cases the patella cartilaginous throughout at the sixth year. It may more rarely ossify with two centers, and this ossification is completed at the age of puberty.

In selecting the x-rays of the patella those of children between the ages of two and one-half and six years were taken for study. In this series of one hundred, the boys and girls were evenly divided. The earliest appearance time of the ossification center of the patella was two and one-half years, when two cases were observed, while the latest time was five years. In thirty-two cases of this series there was no x-ray evidence of a patella being present. In this number there were approximately twice as many boys as girls, the ages being divided as follows: twenty between two and one-half and three and one-half years, eight between three and one-half and four and one-half years, three between four and one-half and five and one-half years, and one at six years. In all those cases where the patella was present, the length of the patella was measured and the abnormalities noted. These measurements have no real value because of the variance of the distance of the x-ray tube from the plate, but they do show the relative degree of development of the patella. This is used in determining the development in the presence of tuberculosis, congenital lues, and rickets.

In the presence of pulmonary or bone tuberculosis, there was no delay

					2½ - 3½ yrs				3½ - 4½ yrs				4½ - 5½ yrs				5½ - 6 yrs			
		Total	Boys	Girls	Total	%	Boys	Girls	Total	%	Boys	Girls	Total	%	Boys	Girls	Total	%	Boys	Girls
All Types	All Cases	100	50	50	35	35	17	18	21	21	9	12	31	31	19	12	13	13	5	8
	No Ossification Center	32	21	11	20	63	11	9	8	25	6	2	3	9	3	0	1	3	1	0
Tuberculosis	All Cases	25	12	13	7	28	4	3	5	20	3	2	11	44	5	6	2	8	0	2
	No Ossification Center	10	8	2	5	50	4	1	4	40	3	1	1	10	1	0	0	0	0	0
Rickets	All Cases	16	4	12	10	62	3	7	3	19	0	3	2	12	1	1	1	6	0	1
	No Ossification Center	11	4	7	8	73	3	5	2	18	0	2	1	9	1	1	0	0	0	0
Congenital Lues	All Cases	14	7	7	2	14	1	1	4	28	0	4	4	28	3	1	4	28	3	1
	No Ossification Center	4	3	1	2	50	1	1	0	0	0	0	1	25	1	0	1	25	1	0

Table Showing Analysis of 100 X-rays of Patellae in Children Between 2½ and 6 yrs.

in the appearance time of the ossification center, but there was a definite retardation in the ossification itself. There were twenty-five cases in this group, in ten of which there was no x-ray evidence of a patella. In four of these children, five years of age and with tuberculous spines, who had been on frames from nine months to two years, there was a marked delay in the ossification, while in two other cases of tuberculous spines, aged four, there was no ossification center present.

In rickets, there was a definite delay in the appearance time of the center of ossification. In this group of sixteen cases, there were eleven showing no x-ray evidence of a patella. In one of these cases, a boy of four and one-half years, there was a lateral dislocation of the patella on the right knee but not on the left, neither patella showing an ossification center.

In a group of fourteen cases of congenital lues, there was no constant effect on either the appearance time of the center, or in the development of the ossification.

There were four cases over four and one-half years of age which showed no ossification center, as follows:

(1) Boy aged 6 with an old anterior poliomyelitis and congenital lues.
(2) Boy aged 5¼ with malnutrition (case reported below).
(3) Boy aged 4¾ with rickets and pulmonary tuberculosis.
(4) Boy aged 4¾ with congenital lues.

In the appearance of the ossification centers in normal knees the following abnormalities were noted:

(1) 5 patellae with a pointed superior border.
(2) 3 patellae with a markedly pointed inferior border or apex.
(3) 2 patellae with two definite ossification centers; the first case shows the second or smaller center situated at the apex of the patella of about one-tenth the size of the larger center; the second case shows the smaller center situated at the superior external angle of the patella of about one-fifth the size of the larger center.
(4) 2 patellae with an irregular roughened appearance of the inferior border.
(5) 1 patella with an irregular roughening on the anterior surface and superior border.
(6) 1 patella with a depression on the anterior surface.
(7) 1 patella with a depression on the posterior surface.
(8) 1 patella with a depression on the anterior and posterior surfaces.

CASE REPORT — *Children's Hospital School:* —

Name: C. A.
Date of admission: November 30, 1925.
Date of discharge: December 20, 1925.
Diagnosis: Delayed ossification of patellae, malnutrition, hypertrophy of tonsils.
Age: 5 years 3 months.
History: —
Complaint: Stiffness in right knee and sore on left knee-cap.
Present illness: The onset was two months prior to admission with sudden pain in the right knee followed by stiffness, since which time the pain has subsided, but the knee

has been quite stiff, especially in the morning and after sitting down. There was a very slight amount of swelling accompanying the onset which has since disappeared. The patient says that he fell and struck both knees during the summer which was not followed by any unusual amount of pain. A sore developed on the left knee-cap which has persisted and has discharged a small amount of pus around the edges of the scab. For the last six months the patient has awakened suddenly at night, cried out, and complained of something hurting, but has never said where it pained him. The mother has thought these were "growing pains".

Past history: General health has been poor. Measles at 2 years which was followed by scarlet fever. Pertussis at 3 years. No other infectious diseases. Circumcision at 20 months.

Delivery was normal, weighing 12½ pounds (?). Breast fed to 22 months. Walked at 16 months. Talked at 2 years.

Head and neck — Two months ago had an earache on both sides

FIG. 1

Case of Delayed Patella Ossification. Boy aged 5 years, 3 months.

FIG. 2

Lateral view of right knee showing no ossification center of the patella. The faint outline of the cartilaginous patella can be made out.

which was followed by a discharge from both ears. Has had frequent attacks of tonsillitis associated with a croupy cough during the winter.

Cardio-respiratory — Frequent colds, which are always associated with a cough. No hemoptysis or expectoration.

Gastro-Intestinal — Appetite poor, but bowels regular.

Other systems entirely negative.

Nutrition — Mother feels that the patient has lost weight in the last 2 years.

Family history: Mother and father living and well. 2 brothers and 2 sisters living and well. 1 brother has a "deformed foot". Mother had "inflammatory rheumatism" for 3 months when nursing the patient. 1 grandmother died of heart trouble. No tuberculosis, cancer or insanity in the family.

Physical examination: — Temperature, pulse and respiration normal.

FIG. 3

Anterior posterior view of both knees showing no ossification centers of the patellae.

Height — 43¼ inches. Weight 38¼ lbs. (6 lbs. underweight for height).

General appearance is that of a rather poorly nourished and developed white boy of 5 years who is in no discomfort at the time of examination.

Skin and mucous membranes — Show a slight anaemia.

Glandular system — Enlarged glands in both axillae and inguinal regions.

Mouth and throat — The teeth show many devitalized ones, and are in poor condition. The tonsils are much enlarged, almost meeting in the mid-line, and are slightly injected. The patient breathes with his mouth open.

Neck — This is symmetrical, and shows no enlargement of the thyroid which is non-palpable. No enlarged glands.

Heart and Lungs — Negative. Blood pressure 95/50.

Abdomen — The liver edge is palpable about two finger-breadths below the costal margin in the right sternal line.

Special Condition:

Right knee — There is a little fullness in the infra-patella pouches with no tenderness, redness, or increase in local heat. No muscle spasm. The patella can be definitely palpated, is freely movable and not tender or enlarged. No limitation of motion in the joint.

Left knee — There is a sore over the patella with scab formation, beneath which there is a small amount of pus. Around this to the edges of the patella the tissues are reddened, indurated, and slightly tender. The patella can be definitely palpated, is freely movable, and not tender. There is no muscle spasm. There is no limitation of motion.

Gait — The patient walks with the body thrown forward on the balls of the feet. The knees do not seem to flex normally as he walks, and the feet have a a tendency to be dragged.

Laboratory examinations:

1. Urine — Clear in color; acid in reaction; sp. gr. 1020; no sugar, albumin, or acetone; microscopic examination shows only a few crystals.

2. Blood — Hb. 77% (Sahli). R.B.C. — 5,320,000. W.B.C. — 7,800.
   Differential — Pmns.— 56% Large Lymph — 5%.
   — Pmbs.— 2 Large Monos. — 4
   — Pmes.— 2 Transitionals — 1
   — Sm. Lymphs — 30%.
   Impression — Slight secondary anaemia.

3. Blood chemistry — (1) Non Protein Nitrogen — 26 mgm. per 100 cc. Normal
   (2) Sugar — 82 " " " Normal
   (3) Carbon Dioxide — 64.8% Normal
   (4) Creatinin 2.2 mgm. per 100 cc. High
   (Normal .5 to 1.5)
   (5) Calcium — 10.5 mgm. per 100 cc. Normal

(6) Phosphorus — 5. mgm. per 100 cc. Normal
(Calcium-Phosphorus Product — 52.5 Normal.)

4. Blood culture — No growth after 5 days.
5. Blood Wasserman — Negative with both water-bath and ice-box fixations.
6. Basal metabolism — Plus 15 High.
Calories per diem—900.
7. Tuberculin test — Intramuscular injection of .5, 1.0, and 2.0 mgm. of old Tuberculin on 3 successive days.
Negative for both local and general reactions.

X-ray reports: — (All bones)

No ossification centers have appeared for patellae which should be present at the third year. No ossification centers have appeared for the upper epiphyses of the fibulae, lower epiphyses of the ulnae; the trapezii and semilunars in the carpus; the second cuneiforms, and naviculars in the tarsus, all of which should have appeared by the fifth year.

Coxa valga bilateral — Angle of neck to shaft is 140 degrees.

Course in Hospital:

The patient was kept in bed during the entire time. The sore on the left patella healed completely and left only a small area of induration. The temperature varied from 97.2 to 99.8, with no afternoon elevation. Refused to have tonsil and adenoid operation done, and refused further treatment. Discharged in excellent condition.

COMMENT

In this one case reported, the outstanding factor is the undernutrition of the patient. The whole picture of being six pounds underweight, with enlarged tonsils, bad teeth, a high basal metabolic rate, a high blood creatinin, and a secondary anaemia certainly points toward a metabolic basis. The normal calcium and phosphorus in the blood is somewhat contrary to what might be looked for in a disturbance of ossification. The history of one brother having a "deformed foot" is the only suggestion of a congenital factor, which probably does not enter into an explanation.

It is significant that there were approximately twice as many boys as girls with no ossification center present, and that all cases over four and one half years were boys. The retardation of the development in tuberculosis can be explained by the relative inactivity of the patients. It has been proved that lack of exercise of parts will cause a delay in bony growth. In rickets the failure for the normal appearance of the ossification center can be explained on the basis of a low calcium-phosphorus product which is known to occur in these cases, and which affects bone deposits. In the two cases of congenital lues over four and one-half years with no ossification center, the lues may have had some effect on this condition, but this is not a constant observation, as in the other twelve cases of congenital lues there was a normal development of the patella.

The first case observed with two ossification centers may be similar to the case reported by Joachimsthal in 1902, where there was an abnormal bony point limited to the apex of the patella which persisted to adult age.

The second case is undoubtedly comparable to the six cases reported by Adams and Leonard, where the upper and outer quadrant of the patella showed a separate piece of bone.

CONCLUSIONS

(1) An analysis of one hundred x-rays of knees of children between the ages of two and one-half and six years shows an absence of the ossification center of the patella in thirty-two.

(2) Tuberculosis has a definite effect on the development of the ossification of the patella, rickets has a definite effect on the time of appearance of the ossification center, while congenital lues has no constant effect on either.

(3) In the case reported of delayed appearance of the ossification centers of the patellae, the undernutrition of the patient stands out as the most important factor.

(4) Two cases are observed with two ossification centers for the patella.

Note: The advice of Dr. Baer and the assistance rendered by Dr. Baetjer in the interpretation of the x-rays has been greatly appreciated.

BIBLIOGRAPHY

1. Thorndike, A. Trans. Am. Orthop. Assoc., XI, 206–218, 1898.
2. Joachimsthal: Arch. f. klin. Chir., LXVII, 342–368, 1902.
3. Mouchet, A.: Paris Med., XXXIX, 289–291, 1921.
4. Todd, T. Wingate and McCally, W. C.: Ann. Surg., LXXIV, 775–782, 1921.
5. Adams, J. D. and Leonard, R. D.: Surg. Gynec. Obst., XLI, 601–604, Nov. 1925.
6. Piersol's Human Anatomy, 1907.
7. Gray's Anatomy: Lewis Edition, 1924.
8. Gray's Anatomy: Da Costa and Spitzka Edition, 1908.

AVULSION FRACTURE OF THE TUBEROSITY OF THE ISCHIUM*

BY HENRY MILCH, M.D., NEW YORK

Adjunct Surgeon, Broad Street Hospital; Adjunct Orthopaedist, Hospital for Joint Diseases, New York City

Fractures of the ischium associated with those of other pelvic bones are not unusual. They are ordinarily the result of external injury and, while interesting from the therapeutic standpoint, they offer no element of novelty either in diagnosis or in comprehension. Isolated fractures of the ischium, on the other hand, are a distinct rarity and but little reference is made to them in the literature. In the German literature there are several references to fracture of this bone,[3, 8] and the statement is even made that fractures of the tuberosity may occur as a result of muscular violence. In the English literature, however, most writers ignore the subject completely. Stimson[11] observes that "it is one of the rarest fractures of the pelvis", while Cotton[2] remarks that, though the diagnosis is in most cases not justified, he has no doubt that it may occur. In a footnote he tersely reports: "At last, November 1922, I have seen a case resulting from a sitting fall in a woman. Save for local soreness, no symptoms."

Malgaigne[6] appears to be the only author who has discussed these cases at some length, although he, too, had no personal experience. He refers to six cases reported by Maret[7], Cooper[12], Laurent[5], Papavoine[9], Jobert[1], and Rankin[10], but remarks that he "would not vouch for the accuracy of the opinions as to the precise seat of the fracture". Of these only Malgaigne's reference to Rankin could be confirmed. Rankin's patient fell a distance of thirty feet from a causeway and suffered a compound fracture of the humerus as well as serious injuries to the perineum and scrotum. The ischium was found detached from the pelvis posterior to the cotyloid cavity. Recovery followed after a long period of convalescence. With the exception of the case quoted by Papavoine, all of these fractures were the result of severe external violence, either long falls, a gunshot wound, or mine explosion. Papavoine's case was that of a woman who two years before had suffered a double vertical fracture of the pelvis with subsequent narrowing of the pelvic outlet. During artificial delivery, made difficult by the results of her injury, the ischium was broken. The diagnosis was not made clinically and the condition was discovered accidentally at autopsy.

In discussing these cases Malgaigne notes that the ischium may "sometimes be separated almost entirely in front of the descending ramus of the pubis and posteriorly from the cotyloid cavity which remains intact, while sometimes it is only the tuberosity which is detached from the bone". In all cases the fragments remain in contact without any noticeable displacement,

*From the service of Dr. H. Finkelstein, Hospital for Joint Diseases, Dr. H. W. Frauenthal, Surgeon-in-chief.

though "it might be presumed that the powerful muscles inserted into the tuberosity would draw down the detached portion if all the fibres were ruptured as in Jobert's case".

In 1912 Berry[1] reported the only case thus far in the English literature, in which a fracture of the ischium occurred solely as a result of muscular violence. His patient was a man aged twenty-three, who three years before, while running in a foot race, suddenly felt something crack in his left buttock, and fell to the ground. He complained of severe pain and soreness in this region and was unable to stand or walk. After the acute symptoms had subsided, the soreness and weakness in the leg grew persistently worse, so that at the end of three years he was unable to carry on. Because of the pain he could neither sit in a hard chair nor bend forward. When standing in certain positions, motion of the leg caused pain and an audible grating. A hard mass could be felt to the outer side and below the level of the normal position of the tuberosity. A stereoscopic roentgenogram showed that the mass was a detached fragment of the ischium displaced downward and somewhat backward. This mass Berry removed with great relief to the patient, though soreness was still present a month after operation.

The following case appears to be noteworthy because it may be of some value in understanding the mechanism involved in the production of this type of fracture.

Dorothy T., aged 11, came to the dispensary, March 8, 1926, because of a limp which had persisted since an injury ten days previously. She had been engaged in practising the steps of a fancy dance and the injury had occurred in the following manner: While lying extended on the right side, her body rigid, and supported by the right hand and the right foot, she had suddenly attempted to do a "split". In performing this manœuver the legs, held extended, were widely abducted, so that the whole length of the limbs touched the floor with the performer in a sitting position. The torso was held upright and turned so as to face the right leg. In attempting to regain the upright position, the patient "felt something slip" and immediately fell backward, unable to arise. She complained of great pain in the right buttock, radiating downward along the course of the hamstring muscles. The knee was held flexed and every attempt to extend the leg caused increased pain. Sitting was painful and she was unable to stand. When examined about an hour later, the pain had persisted in its intensity. No ecchymosis was seen and the physician made a diagnosis of muscle sprain for which he treated the patient. Within several days, the acute symptoms subsided and she was permitted to be out of bed. Then she noticed that her right leg appeared longer than her left, and caused the limp for which she came to the out-patient clinic.

A slight limp to the left and a slight unsteadiness in gait were noticed. There was no pain on direct pressure over the tuber ischii nor was there any evidence of recent ecchymosis. The distance from the anterior superior spine of the ilium to the corresponding internal malleolus measured 81½ cm. on either side. However, the distance from the xiphoid to the right internal malleolus was 110½ cm. while to the left it was only 109½ cm. Motion in the left hip joint was unrestricted. The right hip could be fully flexed upon the body with the knee flexed, but with the knee in extension, there appeared definite pain and limitation of motion. Adduction, internal rotation and extension of the thigh were painful. Against resistance, the extensors of the right thigh were found to be not as powerful as those of the left. Rectal examination of the ischium, as well as pressure on the sacrosciatic ligament, elicited a sharp, painful response. A stereoscopic

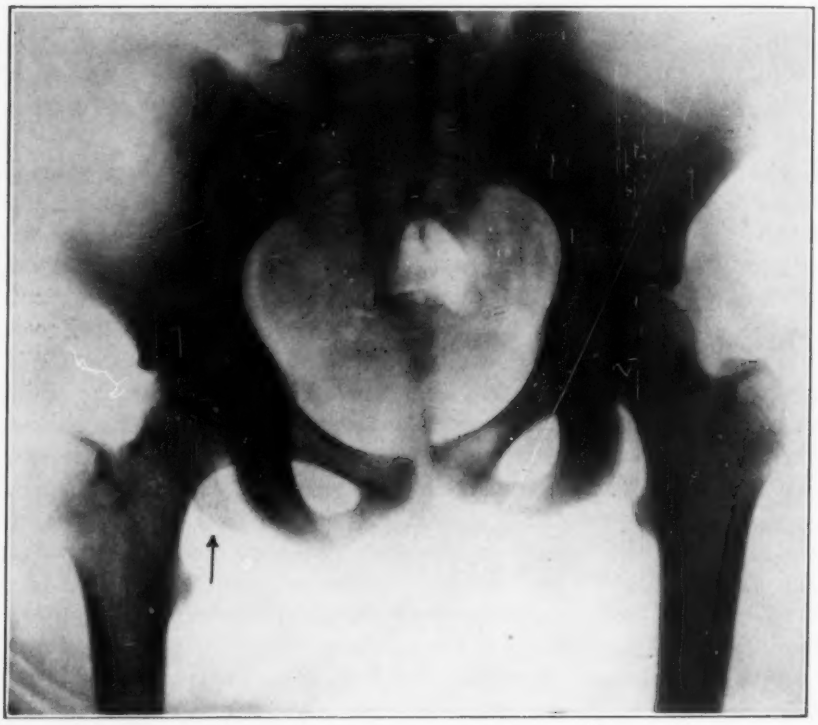


FIG. 1

Roentgenogram showing avulsed tuber ischii on right. Note normal epiphysis on left and separation of symphysis pubis.

roentgenogram showed a crescentic shadow of exactly the same shape as the tuberosity, displaced somewhat posterior and lateral to the body of the ischium. On the left side the epiphysis of the tuberosity was clearly outlined, attached to the main portion of the bone. There was a separation of the symphysis pubis, with a rotation downward and somewhat to the right of the entire right half of the pelvis (Fig. 1). The superior sacro-iliac joint space was somewhat widened.

The patient was put to bed and within several days practically all of the motions of the right hip except adduction could be performed without any pain. The shortening disappeared and palpation showed both pubic bones to be in apposition. No plaster or traction apparatus was applied and at the end of four weeks the girl was allowed to leave the hospital for observation in the follow-clinic.

Strictly speaking, this, as well as Berry's case, appear to be instances of separation of the epiphysis of the ischial tuberosity rather than fractures of the ischium. This epiphysis develops from a separate center and does not unite with the body of the bone until between the twentieth and twenty-fifth years. In fact, it is one of the last to unite with the bony skeleton. As in the other bones of the body, the same forces that, in the adult produce fractures, in the young result in epiphyseal separations. Berry's patient was an athletic adult in whom the fragment might be expected to be larger than in the case here recorded. But the shape of the

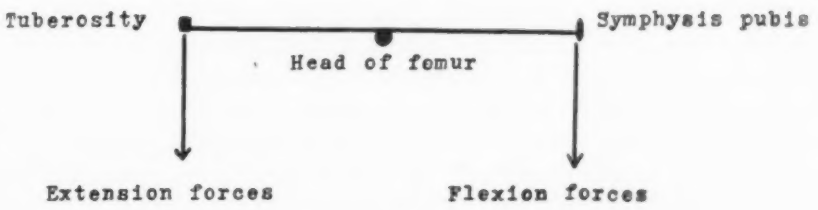


FIG. 2

Shows the normal counterbalancing of forces in the adult in whom the epiphysis has united to the body of the ischium.

fragment, the mechanism producing the separation, and the fact that the patient was still within the age limit when the epiphysis might still be incompletely united tend to support the opinion that this, too, was an epiphyseal separation.

Beyond the belief that the violent pull of the hamstring muscles is the prime factor in the production of this injury, nothing has been described as to the mechanism involved. The fortuitous fact that this girl also suffered a separation of the pubis may aid in throwing some light on this phase of the subject.

In the adult the pelvis may be considered schematically as a lever of the first class. The two arms are the pubic and ischial rami with the fulcrum situated along an imaginary line drawn between the two femoral heads (Fig. 2). The iliopsoas and the muscles attached to the pubic bone from the acetabulum forward to the symphysis pubis act, in general, to flex the pelvis on the thigh. The muscles attached posterior to the acetabulum, and particularly those inserting into the tuberosity of the ischium, tend to extend the pelvis. The flexion force acquired along the pubic arm is transmitted over the head of the femur and counterbalanced by the extension force acquired along the ischial arm. Both lever arms are solid

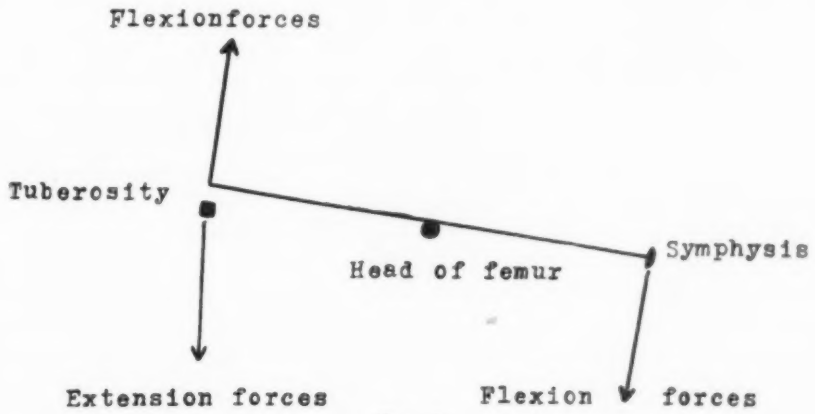


FIG. 3

Shows the application of shearing forces at the epiphysis in those in whom the epiphysis has not yet united.

and quite rigid, and motion occurs over the fulcrum. In the youthful individual in whom the tuberosity epiphysis is not yet united the conditions are somewhat different. The flexion force is transmitted over the head of the femur to the epiphysis. The extension force, instead of being applied along the whole length of the ischial lever arm, is concentrated almost entirely at the tuberosity. Since the back of the pelvis rises as the pelvis is flexed, the whole flexion force may be considered as acting in an upward direction at the epiphysis while the entire extension force is acting downward at the same point (Fig. 3). This converts the pelvis into a second class lever in which the fixed point may be taken as the head of the femur. The flexion lever arm may then be considered as the distance from the acetabulum to the epiphysis of the tuber ischii while the extension lever arm extends from the acetabulum to the tuberosity. Ordinarily, the tensile strength of the epiphysis is sufficient to prevent any separation, as the infrequency of cases would attest. But in the event of any excessive strain it might be expected that the epiphysis, the locus minoris resistentiae, would yield first and an avulsion fracture would result. This appears to have been the situation in the case here reported.

In attempting to assume the upright from the sitting position in which this patient received her injury, the epiphysis was subjected to the shearing mechanism outlined above. With the foot as the fixed point and the whole limb held rigid in extension, the adductor and flexor groups of muscles fixed the pelvis and, acting over the fulcrum of the head of the femur, tended to pull the ischium upward and inward away from the epiphysis of the tuberosity. At the same time, the hamstrings, the gemellus inferior, and the quadratus femoris, in an attempt to extend the pelvis, tended to pull the tuberosity downward and outward. The result was a separation of the tuberosity. The adductor and flexor muscles, then left unopposed and continuing to act, tended to approximate the symphysis pubis to their insertion on the femur. The symphysis gave way, the sacro-iliac ligaments

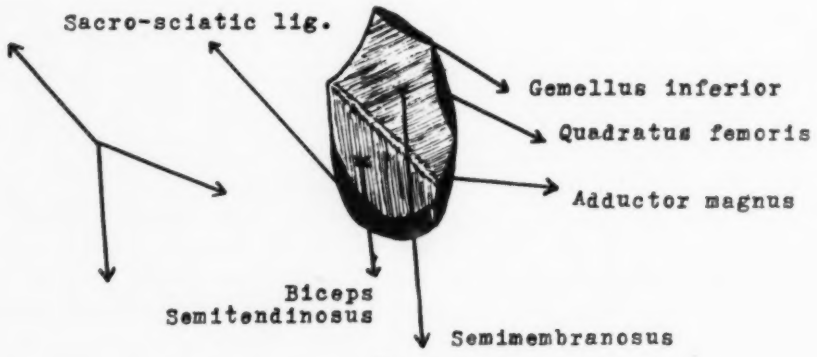


FIG. 4

Shows the attachments of muscles and ligaments to the posterior surface of the tuber ischii. The direction of pull is indicated by the arrows.

were torn, and, as a consequence, there was a rotational displacement of the whole right half of the pelvis downward and to the right.

The tuberosity, once detached from the body of the ischium, was displaced according to the resultant of a number of forces acting directly on it (Fig. 4). The hamstrings tended to pull it downward and slightly forward and outward. The posterior fibres of the adductor magnus and the quadratus femoris acted to displace it forward, outward, and downward while the great sacrosciatic ligament resisted these forces with an upward and inward action. Unless ruptured, this powerful ligament becomes the anchor sheet of tuberosity in limiting the displacement arising from muscular contraction. Usually, the resultant of these forces is of slight torsional moment and therefore the fragment is but little displaced.

When one considers the frequency with which, in the activities of youth, the tuberosity must be subjected to similar stresses and strains, it seems really remarkable that so few cases should have been recorded. It may be, of course, that the condition is more common than has been supposed and has been erroneously diagnosed as a sprain of the hamstring muscles. Indeed, had it not been for the keen analysis and careful observation by the roentgenologists of the hospital, Drs. Bucky and Pomeranz, it appears quite likely that the diagnosis would not have been made even in this case. While the roentgenogram, and preferably stereoscopic roentgenograms, must remain the court of last appeal in establishing a positive diagnosis, there seems, in retrospect, to be certain outstanding points which may be helpful in suggesting the diagnosis clinically.

The condition may be expected to occur in individuals in whom the tuberosity has not yet become firmly united to the body of the ischium, i.e., in those under twenty-five years. There will be a history of having engaged in some activity in which excessive strain was placed on the hamstring muscles at a time when the pelvis was fixed in a position of flexion. There will be pain over the tuberosity radiating along the course of the hamstrings. Flexion of the thigh with the knee in extension will cause increased pain, while with the knee flexed and the hamstrings relaxed this will not occur. On rectal examination the tuberosity will be found tender and pressure on the sacrosciatic ligament will cause traction on the fragment and arouse exquisite pain. Though I have never seen this latter sign described, it seems as if it might be almost pathognomonic of a fracture at either the sacral or the ischial attachment of the ligament.

The prognosis in fractures of the ischium is good. There is practically no interference with motion and the only indication for operation is, as in Berry's case, the persistence of pain. Usually rest in bed and simple immobilization with the knee in flexion is sufficient. To overcome the distorting traction of the muscles attached to the tuberosity the thigh should be placed in extension and external rotation with slight abduction. This is most easily accomplished by keeping the patient flat on the back with the torso somewhat elevated so that the knees can be flexed without discomfort.

REFERENCES

1. Berry, John M.: Fracture of the Tuberosity of the Ischium due to Muscular Action. J. Am. Med. Assoc., LIX, 1450, Oct. 19, 1912.
2. Cotton, F. J.: Dislocations and Joint Fractures Ed. 2, Philadelphia, W. B. Saunders Co., 466, 1924.
3. Jensen: Arch. f. klin. Chir., CI, 361, 1913.
4. Jobert: Plaies d'Armes à Feu, 224. Quoted by Malgaigne.
5. Laurent: Histoire de Percy, 99. Quoted by Malgaigne.
6. Malgaigne, J. F.: Traité des Fractures et des Luxations. Ballière, I, 648, 1847.
7. Maret: Memoires de l'Académie de Dijon, II, 85, 1774. Quoted by Malgaigne.
8. Matti, H.: Die Knochenbrüche und ihre Behandlung. Springer, II, 333, 1922.
9. Papavoine: Journal de Progrès, XII, 234. Quoted by Malgaigne.
10. Rankin, G.: Gaz. méd. de Paris, 2nd Series, I, 53, 1833.
11. Stimson, L. A.: Fractures and Dislocations, Ed. 8, Philadelphia, Lea and Febiger, 357, 1917.
12. Cooper, Sir Astley. Quoted by Malgaigne.

2178 BROADWAY
NEW YORK CITY

PROTEIN ARTHRITIS*

BY PAUL B. MAGNUSON, M.D., CHICAGO

In the course of the last fifteen years many cases have been seen in which there was injury with subsequent joint pain that continued for many weeks and months without apparent cause for the long disability. In investigating the reasons for this, our conception of arthritis as being universally due to infection or trauma with infection superimposed has been upset. In searching for a cause for these long continued disabilities, always with the possibility of focal infection in mind, a type has been found which is not compatible with our knowledge of infectious arthritis of a chronic nature. This is typified by joints which feel "stiff" especially after rest, which are somewhat improved after motion has been established for a few minutes or hours. Pain is frequently more acute during resting periods and immediately after the joints are put in motion. This is contrary to my conception of an infectious inflammation in joints, inasmuch as inflammations are made worse by use, and the more they are used, the more pain is elicited; whereas, in this type, after the patient "gets going", he can go fairly well until he sits down and rests for a time, when again the pain occurs and persists until exercise has "limbered him up". The pain in these joints is frequently preceded or accompanied by crackling. For a considerable length of time after the original onset of pain there is no swelling. This, however, may develop later, at which time the picture is entirely changed and, if seen at this stage, the diagnosis must be made from the history and the chemical blood findings. It is always slow in onset unless preceded by injury, but frequently goes on to spur formation exactly as the ordinary type of osteo-arthritis, so far as can be determined clinically. The joints most frequently involved are those of the lower spine, the hip, the knee and the fingers, with not infrequent involvement of the subdeltoid and subacromial bursae.

About six years ago there came to my office a bridge construction engineer who lived in the open, did hard work, was in perfect health so far as he knew, the complaint that brought him being backache which came on at night. His story was that he could sleep for an hour and a half or two hours after a day's work, and then was awakened by a severe backache; no other symptom. He would get up and move around for fifteen minutes or half an hour, the more active the moving, the quicker the relief. He would go back to sleep for another period of an hour and a half or two hours, and this performance was repeated several times during the night. He was the picture of health, with a ruddy skin, big muscles,

*Read by Dr. MacDonald before the American Orthopaedic Association at Atlanta, April 28, 1926.

no limitation of motion in the back, no joint involvement of any kind, no foci of infection or history of infection. He said his digestion was good; that his bowels moved regularly; that he drank large quantities of water because he was working out of doors in the summer and perspiring profusely.

This was a strange history and the man was induced to spend a few days in the hospital for study and to give us time to ruminate. It occurred to me in the course of these ruminations that such a condition might possibly be caused by an overload of toxines in the blood, which, because of a slowed circulation in the recumbent position, were deposited in the great ligaments of the back, inasmuch as their circulation is extremely sluggish and, at a time when elimination was not actively progressing, there might be an accumulation of irritating products in the ligaments which was causing this pain during rest, the poisons being better thrown off during exercise.

After careful examination it was demonstrated that there was a total absence of hydrochloric acid in the stomach; that there was a large excess of indican in the urine; and the history showed that the man was living on a high protein diet and had one supposedly normal bowel movement a day. He was put on treatment which consisted of a low protein intake, eliminating purines so far as possible, with increased fluid intake, and an increase in the intestinal elimination, and, in this case, hydrochloric acid with his meals. He reported that within ten days his symptoms had entirely cleared up and they have remained cleared up, except when he returned to a high protein diet and did not maintain elimination in the way of water intake and intestinal output, at which times his symptoms recurred.

This treatment was based on the theory that high protein intake was associated with symptoms of pain and irritation, due, possibly, to faulty protein metabolsim. The investigation from a clinical standpoint of cases which might be due to this same condition has been carried on for a period of over five years and covers a series of several hundred cases from which one hundred representative cases have been taken for the purpose of arriving at some conclusion as to the uniformity of certain findings; not selected with the idea of proving this theory.

Pain was present in all cases. The history brought out in all cases that the patients took meat at least once a day in the large majority; in some cases twice a day; and in very few three times a day. The large majority claimed "normal" bowel movements or aided intestinal elimination by use of cathartics. Tenderness over the joints involved was present in all cases. Temperature was absent. Muscle spasm was present in the advanced cases or cases of considerable length of standing. This rigidity sometimes was relieved by exercise, but frequently in cases where there was acute pain was not so relieved. Local application of heat gave uniform relief of pain but did not eliminate it. The most striking thing in the diagnosis, it seems to me, is the history of stiffness in the joints, coming

on after short or long periods of rest and being relieved by exercise. This appeared in the early stages of the condition, but not after the condition had existed for a considerable length of time and there were signs of active inflammation in the joint such as swelling and tenderness. There was no heat, in spite of the fact that frequently there was swelling in advanced cases. Crackling was a frequent symptom, especially in the joints of the hands and in the knees. The patients were confined to no one type; the condition was seen in a girl of seventeen who was a long distance swimmer, who had developed crackling joints some eighteen months before the examination, which had recently become painful. There were no other symptoms. There was a young man who was in active training on one of the Middle Western football teams; a farmer twenty-six years of age, who had always led an active, outdoor life; a tall, thin woman who did her own housework and took care of her own family in spite of the fact that she had continuous pain, especially when resting, but at the time she was seen was never entirely free from it; a short, fat, plethoric man of the typical gouty type.

All of these cases recovered on the above prescribed treatment and are pointed out to emphasize the fact that it occurs in no particular age or type of individual doing any special kind of work, but can be looked for in any individual from the cradle to the grave.

Out of one hundred cases of low back pain, fifty-nine gave a history of trauma, fifty-seven a history of sciatic pain, and twenty-three showed anaemia. Out of one hundred general joint cases, thirty-eight showed infection and thirty-five an excess of indican in the urine. Of forty-six cases examined for uric acid in the blood, twenty-six cases, or 56 per cent., showed increase above 3.5 mgm. per 100 c.c. Of the twenty-six examined for urea, seven showed an increase over what is considered the high normal of 23 mgm. per 100 c.c. of blood, 34 per cent. But in only one case was there an increase in urea occurring coincidentally with increase in uric acid. In forty cases examined for non-protein nitrogen, twenty-three cases, or 57.5 per cent., showed an increase over the high normal of thirty-five. To the medical man who considers uric acid content of the blood (from a standpoint far beyond my ken and for reasons probably far beyond my ken) to be anything from zero up to 5 mgm. per 100 c.c. of blood, these figures may prove nothing; but from the clinical standpoint and the observation of cases where joint pain is associated with high protein intake there is distinct benefit to the patient in the very large percentage of cases, even in the presence of infection, by the elimination of purines from the diet and the increase in water intake and intestinal output. It may be argued from any scientific standpoint which the person arguing cares to take; the fact remains that the large majority of patients show marked improvement when treatment is directed at lowering protein intake, particularly nucleoproteins, and increasing elimination.

Pemberton has directed attention to lowered sugar tolerance in connection with infectious arthritis. He has also gone somewhat into the

FIG. 1

Note notch at upper medial articular surface of tibia typical of gout. No erosion of cartilage or bone except at this point.

realm of protein metabolism in stating that a creatinin and urea output is not changed; therefore, the fetish of red meat causing arthritis is disposed of, inasmuch as urea is the end product of proteins but is not the end result of nucleoproteins. There may be a discrepancy here which Pemberton or other authors have so far not explained. Our ignorance of protein metabolism allows wide argument on this point, and it is not my intention to go into the theory of protein metabolism or to attempt to prove or disprove that any one substance does cause the symptoms referred to, but the association of high protein intake and certain joint pains has been borne out over a large series of cases so consistently that it seems to me it cannot, regardless of theory, be refuted so far as clinical results are concerned. The results have been too consistent and too startling to be coincident to elimination only. The pediatricians have recognized for many years a condition of protein intolerance in children. This is apparently gradually outgrown. At least it ceases to give symptoms. May not this protein intolerance be carried into adult life?

The treatment is simple but effective. All red meats are eliminated, fish and chicken being allowed. No glandular foods are allowed. No nuts, peas, beans, coffee or tea are permitted. There are prescribed at least twelve glasses of water a day, taken as medicine at definite times and not by guesswork. Bowels are regulated so that there are two good normal movements a day in spite of the fact the patient claims normal bowel movement, on the basis that the train may be on time, but it may be yesterday's train. As a drug, atophan or cincophen, in five or seven and a half grain doses three times a day, aids elimination. The results in the cases of old injury have been perfectly startling; the results with chronic backaches have been almost miraculous in certain cases. People who have had chronic backache, more or less constant, for years, have entirely recovered

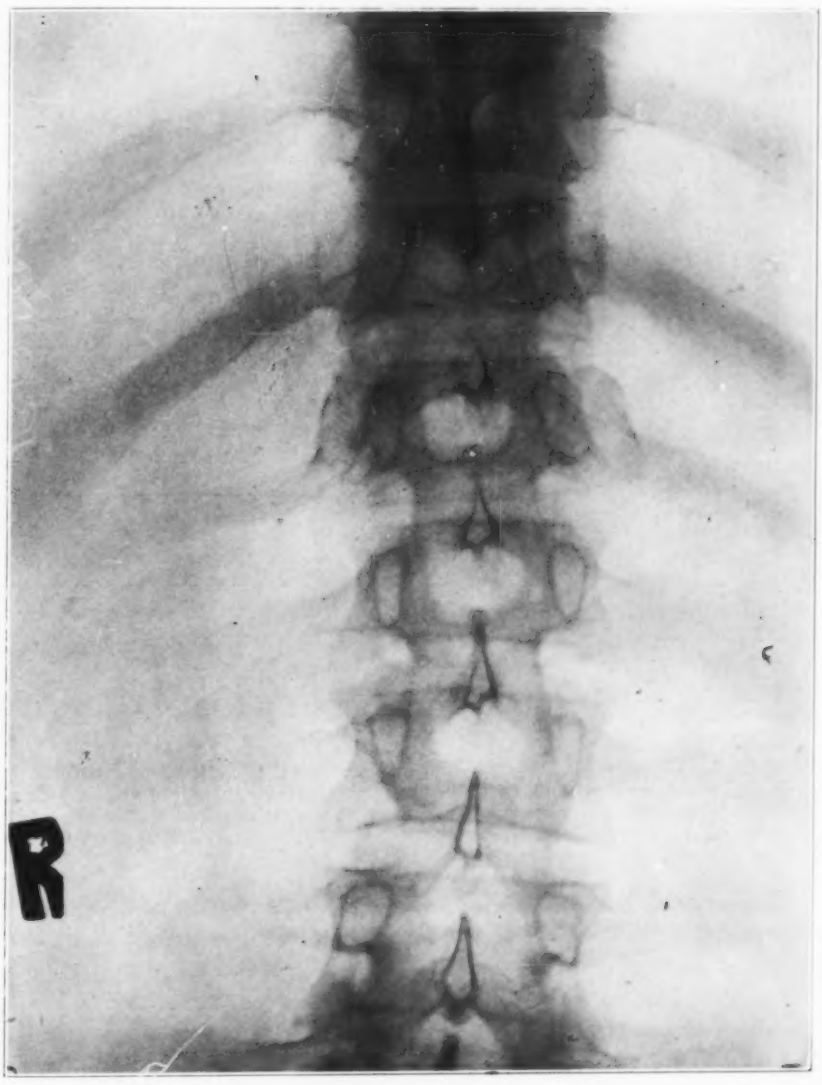


FIG. 2

Osteo-arthritis of the spine in young man of 26 years, disabling him completely from work for four years; constant backache; uric acid 6 plus. Entirely recovered in eight weeks.

without other treatment. A knee which had been diagnosed tuberculosis of the joint and which had shown doughy swelling with only slight heating, limitation of motion and pain after injury, had been disabling patient from work for a year and a half, cleared up in six weeks after the beginning of treatment. Patient returned to work and has been working regularly since (Fig. 1). Cases which showed in the x-ray and from clinical standpoint typical hypertrophic arthritis of the spine (Fig. 2), and others of the hands, knees and hip (Fig. 3), have made complete recovery so far as subjective symptoms were concerned.

FIG. 3

Left hip shows proliferation of bone in capsule as of ossifying myositis following hyperextension and abduction injury. Pain entirely relieved in eight weeks after beginning of treatment. Patient had been disabled previous to that time for seven months.

It is our opinion that at least twenty-five to thirty per cent. of arthritis is due to high protein intake and poor elimination. It is true, of course, that this whole subject is open to argument on the basis that any eliminative treatment will improve the condition of arthritis; that arthritis is frequently a self-limiting disease; that the patients get well in spite of what is done for them; but I do not believe that it can be demonstrated that, within a few weeks of the beginning of a low protein intake and eliminative treatment, complete relief of symptoms can be had in such a large series of cases without some cause or relation being admitted between protein intake and joint irritation and pain.

CONCLUSIONS

There is a definite relation between high protein intake and chronic joint pain; this is not always indicated by high uric acid content in the blood, although it may be.

There is a definite form of arthritis due or associated with incomplete metabolism, poor elimination, or both.

This condition is found in the young as well as in the old; in the lean as well as in the fat; in those of active as well as those of sedentary habits.

THE ORTHOPAEDIC PRINCIPLES IN THE TREATMENT OF CHRONIC ARTHRITIS*

BY LORING T. SWAIM, BOSTON

In order to make the treatment of chronic arthritis rational there are a few clinical details which must be restated. They have been recorded elsewhere, but it will do no harm to review them for a moment.

There are clearly two types of arthritis: the proliferative and the degenerative. From clinical data we believe that the proliferative type is made up of two distinct groups: the infectious and the atrophic. These are distinct manifestations with clinical differences which make them worth studying and treating as entities; for there is an infectious periarticular group of cases where the disease may destroy the cartilage and joint but does not cause bone atrophy such as is found in the atrophic type of arthritis. This atrophic group is found in the slender anatomic type, the visceroptotic, light-boned person, and it has few of the symptoms of an infection but has many of the manifestations of a constitutional disease of a physiologic origin and a biological chemical failure described in a previous paper. This is by far the largest group.

The degenerative or hypertrophic cases are found in the heavy anatomic type of patient, and have few signs of an infective origin. The clinical picture, as well as the rapidity with which the joint irritation subsides with rest and protection, would strongly suggest a strain origin with a chemical background at an age of physiologic sluggishness.

Recognition of these types is important in treatment not only from the standpoint of exercise, because the proliferative tend to ankylose and the degenerative do not, but, as will be seen later, the diet varies in the different groups.

The practical treatment of chronic arthritis, therefore, should be based on the restoration, first, of normal physiology and resistance, and second, of normal joint motion. Our studies have led us to believe that the normal physiologic working of the vital organs of our anatomy is dependent on correct use of the body itself. It has been found also, after careful study of a large group of arthritics, that in most of them the body is posturally deformed, and that this materially interferes with the restoration of normal physiology. With this clearly in mind we must, first, stop the disease and second, repair the damage. This is the ideal and it can be attained in early cases. The first requirement, normal physiology, can be accomplished in many advanced cases, although the second, restoration of normal joint mobility, may not be attained. Nature unaided tends to arrest arthritis

*Read before the American Orthopaedic Association at Atlanta, April 28, 1926.

in the large majority of cases, especially the infectious group. The others need careful systematic control to give nature a chance. In our experience a few patients recover after the removal of some septic focus, while the greater number continue the course of the disease unless other treatment is instituted and persisted in. It is this other treatment I wish to speak of.

Chronic fatigue is one of the chief factors in all arthritis, and is persistent throughout the course of the disease. Not only is it a subjective symptom but the physical signs of it are also present: for example, subnormal morning temperature, poor pulse, vasomotor instability, low blood pressure, lowered metabolism, and poor muscle tone. (See Chart A.)

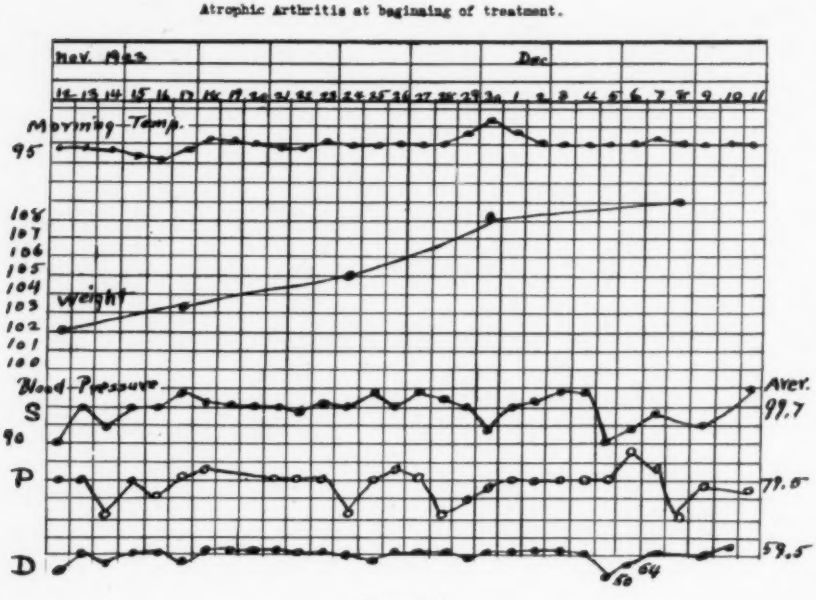


CHART A

Fatigue of this kind is due, we believe, to disturbances of the normal physiology of the organs in the thorax and abdomen, and has its effect chiefly through the circulatory and sympathetic nervous systems as is shown by cyanosis of the lips, cold hands and feet, localized blanching, skin changes, and deranged heart action. Moreover, the same symptoms and signs are found in most cases of poor posture and disappear when correction of this defective use of the body is accomplished. In these patients the stoop-shouldered posture produces a flat chest, contracted ribs, and a low diaphragm with its poor action, and hinders the free return of the blood flow from the abdomen. The abdominal viscera with their abundant circulation are crowded by downward pressure and lack of space under the ribs. The sympathetic ganglia, especially the solar plexus, which controls visceral function and circulatory tone, is disturbed. This may account for

FIG. 1

Hyperextension showing the pillow under the shoulders for expansion of the ribs. This position is used for one-half hour after each meal.

the glandular deficiencies described by Dr. Thompson and the chemical disturbances recorded by Dr. Pemberton, such as lowered sugar tolerance, changes in blood chemistry — all of which are evidences of an abnormal physiology which materially lessens the chances of recovery unless corrected.

In our experience this physiologic derangement has not responded satisfactorily or permanently to any single form of treatment, and it has been necessary to secure the fundamental conditions for normal visceral function — that is, correct body mechanics — so that the vital organs of circulation and sympathetic nerve control, as well as the digestion and elimination, and all of the chemistry, may be corrected and function normally.

In the treatment of arthritis, just as in a decompensated heart, the

FIG. 2

Hyperextension with the arms up, to increase the expansion of the ribs, raising the diaphragm and the viscera.

FIG. 3

Face prone position—pillow placed lengthwise under the body in order to relieve any pressure on the sympathetic ganglia, and to change the circulation by reversing position from the hyperextension.

load must be lightened. Especially in early arthritis, since complete rest is essential, treatment should be in a hospital. Bed is the ideal place for rest and is the ideal place for correction of the deformed body because the hyperextended position takes the strain off the diaphragm. In the first stage of correction certain positions are used. After each meal during the first half-hour of digestion, a pillow is placed under the shoulders and the hands are placed under the head. This raises the chest and diaphragm, flares the ribs, and hyperextends the dorsal spine. The knees may be raised to flatten the lumbar spine. This position results in abdominal breathing and the better use of the diaphragm, promotes circulation, with consequent relief of abdominal congestion (Figs. 1 and 2). At the end of the half-hour a face prone position is assumed, with the pillow lengthwise under the body. This changes the circulation again and removes the pressure of the viscera from the network of sympathetic ganglia and plexuses covering the spinal column. In this position hot fomentations are given over the spine to stimulate spinal circulation (Fig. 3). The patient is allowed up only for meals, one pillow being permitted at other times. Education for correct use of the body is started by exercises, with the definite plan of correcting deformities, and consists of breathing to expand the ribs, stretching the ribs laterally to reshape the chest, tilting the pelvis to flatten the lumbar spine (Fig. 4). This routine is continued for several weeks or until the education in correct body mechanics has progressed far enough to be continued in the upright position with supports and practice.

The result of these positions and exercises is the gradual stretching of the ribs upward, with the increase of the costo-sternal angle toward a right angle. The expansion of the chest gives better circulation and heart action, and, more important still, it raises the diaphragm and produces normal diaphragmatic breathing. Thus the viscera as a whole have the greatest possible space for movement and function, and their position is

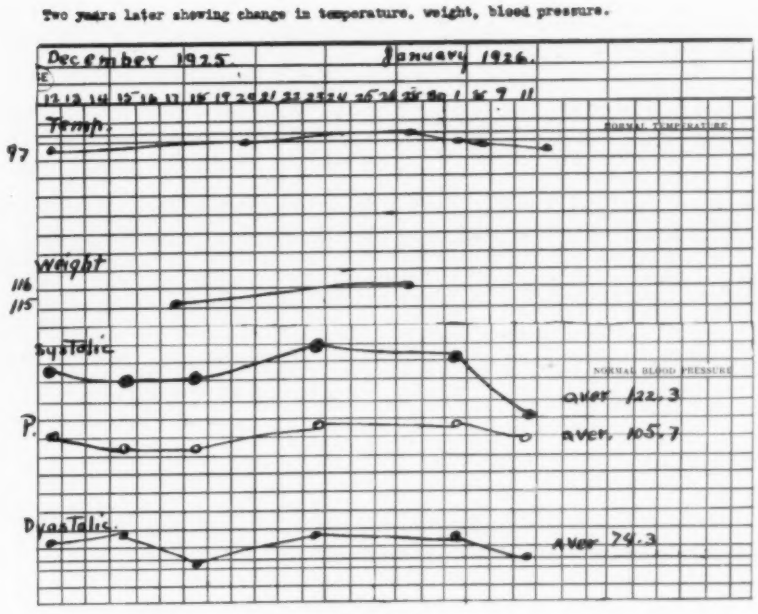


CHART B

changed by each respiration which relieves congestion. The symptoms of fatigue go, the circulation becomes more stable, and the joints improve (Chart B).

Very little need be done at this time for the local joint condition except to prevent deformity and promote circulation with heat and rest. The patient is encouraged to move the joints a little each day. When no other treatment is used it is interesting to see the congestion of the joints disappear and motion increase with the improvement of the visceral function. It would seem as if much of the arthritis was part of a general circulatory failure manifested by congestion.

The next step in treatment is the addition of short periods in the upright position supported by a corrective brace to prevent drooping and to keep the chest high. The exercises are increased to sitting ones, and, as the time up is gradually lengthened, walking is advised. Finally standing exercises are given and activity is encouraged. Each change in the body mechanics is followed up and activity is determined by the congestive reaction of the joints, circulatory stability, and fatigue reactions noted in the patient and on the chart. The one object in this treatment is to put the body in the best possible position, to develop normal physiology, circulatory stability, and resistance for permanent recovery.

Meanwhile medical studies have been instituted. The metabolism has been tested at intervals, the blood pressure records charted, the blood chemistry studied, especial attention being paid to the bowel movements as a guide to the functional powers of the gastro-intestinal tract. The

intestines are frequently found loaded with old foul material, and require repeated clearing with castor oil and irrigations. This should never be overlooked. Medical treatment is instituted whenever indicated and requires no comment here except to point out that the thyroid is apparently often exhausted in these cases, and that when the metabolism is low, as it is in sixty-three per cent. of our cases of the infectious and atrophic group, judicious use of thyroid improves the general tone and particularly seems to improve blood pressure and circulation. Its use seems to hasten stability.

Another point in treatment of atrophic arthritis especially is the use of the vapor bath of Wilde. These cases show acid saliva and sweat, and are greatly benefited by sweating until the skin reactions are neutral. The moist heat of the bath, which increases superficial circulation and causes no debility because of the low temperature required, temporarily raises the temperature and metabolism (Chart C), which is desirable. It can be repeated daily at a temperature of 106°, which is not true of the dry cabinet with its high temperature of 130°. For a time after each bath the joints are more limber and motion is increased. A profound blood change takes place during this bath, the details of which have not yet been worked out. There are a few people who, because of some circulatory peculiarity connected with this blood change, are worse after the heat, and any such should never be sweated.

Metabolism as Affected by Wilde Steam Bath

Steam baths		Metabolism	
		Before	*After*
9/22/23	M.	— 2	+15
10/6/23	L.	— 7	+ 3
10/25/23	W.	—14	—10
11/10/23	D.	— 8	0
11/15/23	D.	+ 1	— 2
11/22/23	I.	— 8	— 2
12/6/23	B.	— 4	+ 6
12/12/23	B.	— 9	— 4
12/14/23	L.	+31	+14
12/20/23	M.	+11	+30
12/27/23	C.	—10	— 2
8/22/23	S.	+14	+16
8/30/23	G.	—16	— 3

Chart C

Metabolism chart showing the interesting change as a result of a steam bath lasting 20 minutes, with a temperature of 102°.

Massage is only used for the abdomen to promote better circulation and stimulate peristalsis. It probably stimulates the sympathetic ganglia because it produces relaxation, and at times a mild perspiration and dilatation of superficial blood vessels.

There are many theories about diet. It probably plays a part in arthritis, and dieting is one way of catering to weakened functions and

lightening the load, as is done in diabetes. If the sugar tolerance is lowered a low carbohydrate diet is indicated, and if the digestion is poor cutting down on the calories may help. We believe that cases of atrophic arthritis should not be dieted but should have an abundance of mineral salts because of their acid saliva and sweat, their loss of bone salts, their excretion of calcium, and thyroid depletion; we give an excess of base-forming foods such as fruits, vegetables, and whole grains, all base-forming foods which form an alkaline reserve as opposed to meats, white flour, white sugar, cheese, meat extracts, candy, and syrups which are acid-forming foods and require alkalines to neutralize them. It is not illogical to suspect that the excess of acid-forming materials, which are increasingly consumed as our foods are more refined, may be a factor in arthritis of the atrophic group.

Pemberton restricts the general caloric intake and lowers the carbohydrate especially, basing this on the lowered sugar tolerance tests. His diets contain much fruit and vegetables. An atrophic case should never be depleted as such a patient is already about as far down as he can safely go. The hypertrophic cases we diet only if they are too heavy, for they are not acid, and, in our cases, they have not shown lowered sugar tolerance. Our experience has been that the best method of dealing with diets is to increase the patients' functional capacity to handle any food through promoting normal physiology, using diets only in extreme cases which would not respond otherwise. Cod liver oil is used in cases where the blood phosphorus is lowered, usually in the active atrophic cases. In the hypertrophic cases showing no calcium and phosphorus imbalance, cod liver oil is not indicated. Sunlight and fresh air are used for the same reason, and are, we believe, very potent factors in building up strength and general tone. At the Robert Breck Brigham Hospital we have found that many cases are not as well during the sunless winter months, but pick up again out-of-doors during the summer. We have, therefore, been experimenting with a Quartz lamp this year.

As for the local joint conditions during the acute stage of all forms of arthritis, when soreness, congestion, and pain of the joints is present, the first great fundamental principle of orthopaedic surgery dominates our treatment. Deformity must be prevented. Positions, protection, and rest do this. Joints at this time should never be manipulated or strained because the resulting swelling mechanically interferes with circulation, and trauma is done to diseased tissues. Painless active motion is encouraged. After the acute stage has passed, however, the second great principle dominates. The joint function must be restored if possible. Our best results have been secured through very gradual use of the joints in exercise and occupational work. Manipulation is used less and less, and the quicker method is being displaced by more gradual and, on the whole, more satisfactory daily exercise with rest periods. By this the muscles are developed to keep pace with the increased range of motion, and better circulation follows, with more permanent results. If, later, operative procedures are necessary to get joint motion, the muscles, having been used,

are ready to do their share in securing motion much sooner after operation, and the chance of adhesions becomes less because of this preparation.

Occupational therapy constitutes one of the most valuable parts of treatment, therefore. It gives normal exercise to the joints and it can be controlled. If done properly, use of the joints increases their circulation, their range of motion, and promotes repair. Miss Taylor, occupational therapist at the Robert Breck Brigham Hospital, has developed a method of charting joint motion which makes the control of work easier and the results of joint activity obvious.

In hypertrophic arthritis, at no time is overuse, trauma, or incorrect use of the joint permissible, for the disease is increased by trauma and hypertrophy is found chiefly at points of the greatest mechanical strain, such as the neck, hip, knee, and back. Rest is the first treatment, protection from strain is the second, and prevention of future strain is the only effective method for permanent relief. Therefore supports, correction of foot and back strains, and above all, correction of faulty body mechanics are essential for relief of strain when upright. Any medical care which is apt to

FIG. 4

Note the bad posture, flat chest, round shoulders, prominent abdomen, generally sagged position, which are found in this patient suffering with the infectious type of arthritis.

FIG. 5

After a year's training note the change in posture, the high chest, flat back, and generally better muscle tone.

speed up the physiological processes and promote elimination is indicated, as these cases are usually beyond forty and are slowing down.

At no time during treatment is the education of the patient in the proper use of his body forgotten. Just as fast as the body mechanics are corrected more exercise is planned until a good carriage of the whole body is secured (Fig. 5). Not only does this leave the patient with the greatest potential for continuation of health in the future but it secures for his joints the least possible strain in use. Improper carriage is the greatest cause of foot, knee, hip, and back strain, and forward position of the shoulders is the worst for the arms.

It will be seen, therefore, that the principle of treatment is to restore the body to a condition of physiologic and functional equilibrium as nearly normal as possible,—one which will cause the repair of joint damage to go on as far as is possible in the particular patient; for it is a fundamental truth, not only of such delicate structures as joints, but for the viscera of the body as well, that correct use promotes health. These principles give the best possible hope for arresting the disease completely. Without lowered resistance we would not succumb to disease, and we would recover from temporary lowering of this resistance more quickly if we did not handicap our internal mechanism by bad habits of food and rest, and bad use of the trunk.

This method of treatment based on the main principles of orthopaedic surgery has been successfully applied to many cases of arthritis. The principles of treatment can be summarized as follows:

1. Recognition of the types of arthritis.
2. Correction of the deformed body in order to allow the normal physiologic functioning of the entire organism.
3. Prevention of deformity during the acute stage.
4. Reconstruction (after the acute stage has passed) of both the body and the joints so that the patient is left in the best possible physical condition to remain well.

BIBLIOGRAPHY

1. Swaim, L. T.: Chronic Arthritis. J. Bone & Joint Surg., IV, 426–445, July, 1922. Swaim, L. T.: Atrophic Arthritis. The Rhode Island Med. J., VI, 51–55, April, 1923.
2. Nichols, E. H., and Richardson, F. L.: Arthritis Deformans. J. Med. Research, XXI, 149–221, Sept., 1909.
3. Goldthwait, J. E.: An Anatomic and Mechanistic Conception of Disease. Boston Med. & Surg. J., CLXXII, 881–898, June 17, 1915.
4. Thompson, H. K.: Endocrine Element in Arthritis. Boston Med. & Surg. J., CXCII, 658–664, April 2, 1925.
5. Goldthwait, J. E.: Ptosis of the Heart and Diaphragm. Important Points for Determination in the Chronic Patient. Boston Med. & Surg. J., CLXXXIX, 581–589, Oct. 25, 1923.
6. Wilde: Physiology of Gout, Rheumatism and Arthritis. New York, Wm. Wood & Co., 1922.

7. Pemberton, R., and Foster, G. L.: Studies on Arthritis in the Army, based on 400 cases, Arch. Surg., XXV, 243–282, March, 1920.
Pemberton, R., and Buckman, T. E.: Studies on Arthritis in the Army, based on 400 cases, Arch. Surg., XXV, 335–350, April, 1920.
Pemberton, R.: Studies on Arthritis in the Army, based on 400 cases, Arch. Surg., XXV, 351–404, April, 1920.
Pemberton, R.: Further Observations on Arthritis and Rheumatoid Conditions, Am. J. Med. Sc., CLXVI, 833–845, 1923.
Pemberton, R., Hendrix, B. M., and Crouter, C. Y.: Studies in Arthritis: The Blood Gases and Blood Flow, J. Metab. Research, II, 301–328, 1922.
Pemberton, R., Cajori, F. A., and Crouter, C. Y.: Influence of Focal Infection and the Pathology of Arthritis, J. A. M. A., LXXXV, 1793–1798, 1925.
8. McCann: The Science of Eating. New York, Geo. H. Doran Co., 1919.
9. Goldthwait, J. E.: The Relation of Posture to Human Efficiency and the Influence of Poise Upon the Support and Function of the Viscera. Am. J. Orthop. Surg., VII, 371–416, Feb., 1910.
Goldthwait, J. E.: An Anatomic Explanation of Many of the Cases of Weak or Painful Backs as well as Many of the Leg Paralyses. Am. J. Orthop. Surg., X, 309–328, Feb., 1913.

DISCUSSION

Note: The paper of Dr. Burbank to which reference is made in this discussion appeared in the *Journal* of July 1926.—*Editor.*

Dr. A. Mackenzie Forbes, Montreal, Canada: I think we may congratulate ourselves on having listened this morning to a series of most helpful and stimulating papers. It always seems to me that a study of infectious arthritis brings together the science and the art of surgery. I think that has been demonstrated to a great extent this morning. Of course we all appreciate that our knowledge of arthritis will be as nothing until we know more about the etiology. Personally, I have always preached the dictum that arthritis in the vast majority of cases is due to infection. Consequently it has been a great disappointment to notice how rarely the eradication of that infection has been followed by relief of the condition. This brings us to the statement I have already made that quite possibly there is a portal of infection which, under our present knowledge, is undiscoverable. Then, with this as a basis, realizing the history of the past, we cannot help turning our attention to the possibility of the portal of infection being an intestinal one. The more I think and talk of this subject with my friends, and even as I have talked at this meeting about this particular theory, the more it has been suggested to me that we shall find, in the end, that the intestines profoundly influence these conditions.

Now we all know that many of these conditions are due to streptococci. We all know that many of these infections are streptococcal in nature and if it should become possible to separate the various strains of streptococci and we should be able to say what particular strain is causing the particular condition, it seems to me that light will probably gradually come to us, and consequently I think that this morning's papers have really helped and will help very considerably, and I for one will go back to the study of these conditions feeling that I have been stimulated to further work by what I have heard today.

Dr. W. W. Plummer, Buffalo, New York: I think there can be no question in the minds of any of us but that progress has been made in the fundamental problem of chronic arthritis. This is shown not only in the papers of this morning, which have been most enlightening, but we should also keep very carefully in mind the two papers of Allison and Key of yesterday afternoon which are very important as to what may be done in the future in the way of solving the difficulties these cases present. We must look at these cases from a practical point of view. We have them always with us and we cannot set them aside until we arrive at the conclusions which I hope some day will

give us a more logical therapy. For a time in the future then, we will have to do some empirical things. I think the plans that have been outlined this morning, while they may seem to conflict, are useful measures. In the light of our present knowledge I see no reason why we should not take advantage of special diagnostic processes that seem to be practical. The best thing that may be said is that we owe to these men who have already done this work, and those that may come, every possible encouragement for further research.

DR. PHILIP LEWIN, Chicago, Illinois: I enjoyed very much hearing these papers and hearing what strides are being made. If a patient with arthritis is to profit by our present day knowledge, he ought to go to Dr. Burbank and allow him to do everything he can, and call in Dr. Swaim and have him do what he can; or go to Dr. Swaim and then call in Dr. Burbank.

A point under etiology that should not be overlooked is the question of heredity. It is evidently a factor.

Age does not seem to matter. We see the disease occasionally in medical students. We have under observation at St. Luke's Hospital a child with Still's disease, a multiple arthritis which appeared thirty-six hours after infected tonsils were removed. As long ago as 1911, Dr. D. J. Davis, working at St. Luke's with some of the patients of Dr. John L. Porter and other attending men, produced conditions similar to those which were shown on the screen today. It was my good fortune to have helped him with some of those experiments.

The relation of arthritis to tuberculosis has not been given its proper recognition or study. The paper by Kessel in 1917 should be read by all interested in this subject.

Another question is the relation to furunculosis and acne. If furunculosis can produce a severe grade of osteomyelitis, why can it not produce arthritis? The question of anaphylaxis and whether it can produce arthritis should be worked out. Shapiro has produced ulcer of the stomach by anaphylaxis; why may it not be one of the causes of arthritis?

The question of blood supply in the spine as a point in etiology is demonstrated by some dried specimens that Dr. Porter has in his collection, showing osteo-arthritis involving only one-half of the spine just as definitely as though someone laid it out with an instrument.

Various points under treatment have been mentioned. One point under cod liver oil is important. Most adults cannot stand even the smell of it. At the Cook County Hospital one of our druggists has a formula for preparing it so that it really can be taken without trouble.

One question I would like to ask any one of the essayists, and that is the explanation of the effects of climate and the effects of changes of weather on the course of arthritis. It is an observation of everyone and I would like to know if any explanation is forthcoming.

Dr. Burbank did not mention whether he ever gave his vaccines intravenously. He also did not say anything about results of treatment.

A point in Dr. Magnuson's paper is this: he eliminates red meats from the diet but allows the patient to eat fish and says nothing about eggs. If you eliminate all animal proteins, you must eliminate meat, fish and eggs. Some of these patients go from one doctor to another, and because one doctor proscribes meat they indulge in eggs and fish.

DR. MELVIN HENDERSON, Rochester, Minn.: I have little of value to add to this discussion. I should like to congratulate Doctor Burbank on his presentation. It is most interesting and it is pleasing to know that there is someone who has the enthusiasm and the will to take these unfortunate patients in hand and treat them according to the best we have in scientific medicine. So often the opposite is the case. In the Mayo Clinic the arthritis patients are taken care of by a combined effort of the medical and orthopaedic services. The former concerns itself with the general care, vaccine therapy, etc., and the latter with the treatment of the local conditions in the joint, such as deformities, etc. We use vaccine therapy and in some cases it seems to be beneficial.

However, the value of vaccine therapy in so far as I am concerned has to be further proven.

In a discussion such as this there are so many things that might be mentioned that it is difficult to make up one's mind what to say. In the severe cases where the patients are bedridden, many of them are in a pitiful condition, as shown by the pictures Dr. Swaim presented. In the last few years we have operated upon some of these cases and by multiple arthroplasties on the same individual we have succeeded in placing them in such condition that they can at least feed and care for themselves and probably get about a bit by the aid of crutches. When the disease is quiescent the patients stand these surgical procedures quite well, but it is difficult to know just when the joints are in the quiescent period. I would not advise arthroplasties on these patients indiscriminately, but I do believe that a certain number when properly selected can be much improved and the risk is slight.

Dr. L. H. Mayers, Chicago, Illinois: About a year ago I had the pleasure of visiting Dr. Burbank's clinic. He also extended to me the courtesy of checking up his clinical diagnoses with his serological tests, and I was sufficiently impressed with the work he was doing to try to check up on it experimentally.

I had no intention of appearing before this society, and merely brought these x-ray films to show Dr. Burbank lesions we were able to produce in our experimental animals with two types of organisms, the haemolytic streptococcus and the streptococcus viridans.

Time does not permit me to go into the details of this experimental work, but our preliminary report will appear in an early issue of the Journal of Surgery, Gynecology and Obstetrics.

The work I have seen with Dr. Burbank has been very instructive, and I have never seen any man entertain as many arthritic cases over as long a period of time and keep them contented. Certainly I think he is to be congratulated and given every support in the work he is doing.

Dr. W. S. Baer, Baltimore, Md.: I am intensely interested in the papers that have been read and I think this is one of the real meetings that we have had. I am unusually interested in arthritis. I think Dr. Burbank should be congratulated, for I believe he is on the right track. There are only one or two points I should take exception to. In the first place, I do not believe that we have any evidence to show that osteo-arthritis is an infectious disease. I believe it is purely a metabolic proposition and it is one of the easiest diseases to clear up. You can clear up this rheumatic diathesis. It is a question of diet, cutting out the sugars and acids. The picture shown by the viridans does not, I think, produce a typical osteo arthritis. It is possible that the viridans may change the contour of the joint.

I do not believe any other organism will cause arthritis of the infectious type except streptococcus. Streptococcus has never been gotten out of the blood in these cases of arthritis. Neither has it been gotten out of the joint itself. As far as focal infections are concerned, you get many organisms. I believe the secret of the thing will be found to have a basis in Rosenau's work, that you can get organisms from glands in certain stages of the disease. If you get the proper case, not the old ones that are burned out, you can get the organisms out of the gland culture in many cases. Some laboratories will give you nothing and some will give you everything. It is a question of bacteriological technique. I have seen instances where it took six weeks before you could grow the micro-organisms.

In regard to the paper of Dr. Magnuson, read by Dr. McDonald, I think he is absolutely on the right track. Osteo-arthritis is a metabolic proposition.

Dr. Reginald Burbank, New York, N. Y. (closing his part of the discussion): I have only a few words to say in summing up the discussion. I do not want you to think that this work is a premature presentation, as more than six thousand cases were treated before we considered publication of our findings. For the article on serological diagnosis, more than a thousand carefully studied complement fixations were used as a basis for

our conclusions. We did not have any theory which we tried to make the cases fit. We had the cases before us and study of them brought the theory as a natural sequence.

I am sorry to have to disagree with Dr. Baer, but we feel that the osteo-arthritic cases are also infective in origin and in this type of case the streptococcus viridans has been the main serological and bacteriological factor. We feel that osteo-arthritis is a systemic infection and not a localized joint involvement only and we feel that it has to be treated as such, taking all possible measures for production of the best results. I think that Dr. Mayers' slide shows an osteo arthritis without pus formation. Dr. Ryerson and Dr. Porter have seen the animals on whom these experimental lesions have been produced and perhaps they will tell us if the lesions were hypertrophic.

We do not give intravenous vaccine. We think it a dangerous procedure in many cases, especially where the resistance of the patient is low.

In speaking of glandular deficiency and metabolic causation in hypertrophic arthritis, we feel that in any infective arthritic case glandular dyscrasia is one of the early symptoms, but not a causative factor of arthritis. To our knowledge no one has experimentally produced osteo-arthritis by causing glandular deficiencies. The menopause arthritis, so called, is in reality only associated with the climacteric because general resistance is low at that period and in consequence bacterial invasion is easy.

There is little more to add on Still's disease. I have not had a large series, only fourteen in all, but I have seen some surprisingly good results in clinic cases without any other treatment than properly used vaccine therapy.

You cannot tell when an arthritic is cured and we do not wish to over-estimate what we are doing, but we do feel that we can say when a patient is symptom free and what we are trying to do is to get them symptom free. For example, in an old Still's disease that has gone to marked deformity with pronounced atrophy, it is impossible to get back all that has been lost. If a case is treated early enough, we believe deformity can be prevented.

Dr. L. T. Swaim, Boston, Mass. (closing his part of the discussion): Last summer Dr. Burbank loaned me his strains of streptococci and I wish I could report the same results that Dr. Mayers did. I tried them on rabbits and I could not get any result. Either it was poor technique or I did not know much about it. I had the rabbits on a definite diet, but it made them sick for only two or three days. Now I want to discover why we did not get the results that they did. Probably it was the technique.

JOINT DISEASE*

A Clinical-pathological Study

BY RALPH K. GHORMLEY, M.D., BOSTON

Orthopaedic Department of the Massachusetts General Hospital

In the series of cases presented here an attempt has been made in so far as possible to bring together the clinical with the pathological study of joint disease. Too often we find the pathologist laboring with tissue without a knowledge of the details of the clinical side of the case. Even more often we find the clinician working on his own without the help of an examination of the tissue he is dealing with. In gathering together the facts here presented, we have been impressed with the interest each has shown in the other's phase of the work, and we are sure the benefits derived have been of the greatest value to all concerned.

It is not our purpose to go into any detail on the pathological side of the question. That in itself is a subject of such great scope that it must be reserved for another publication. Our interpretation of the findings must be given in very brief form. In the pathological studies we have had the closest co-operation of the Department of Surgical Pathology, and we must express our appreciation of their help. The writer has some hesitancy in presenting some cases where the study has not been completed. The necessity of repeating section of bony material necessarily prolongs the work, and for this reason we can not give final diagnoses in all cases. Yet this very fact serves to illustrate a point to be brought out later.

MATERIAL

The material for this paper has been gathered over a period of two years on the Orthopaedic Service of the Massachusetts General Hospital. It represents the result of a concerted effort on the part of the staff to reach a definite diagnosis in all cases of joint disease presenting themselves for treatment. In each of these cases some form of tissue study has been done. In a few the simple aspiration of fluid sufficed to give the needed information. In a much larger group tissue has been removed, sectioned and studied. In many cases the study of the soft tissues of the joint is all we present as the study of the bone has not always been possible, and in some is not yet completed. In others, the bony material has been sectioned and studied.

I have attempted to get together the essential facts of the case histories presented in very brief form, and whatever blood studies were available. Tuberculin and Wassermann reactions, and x-ray reports likewise are very

*Presented as a thesis for membership in the American Orthopaedic Association.

briefly recorded. These being the usual clinical data presented, it is interesting to follow them through and check up, as it were, on those cases where final diagnosis is possible.

Not all of this data is available in each case. In many of the cases done during the early period of the work tuberculin and blood studies were not carried out. As the work has progressed and we have seen the importance of collecting all these facts greater effort has been put forth to find out everything possible about each case.

After tabulating the entire group of cases, as shown in the protocol, we will take the various groups of cases according to their diagnoses for discussion. Of these groups, the first and most important is tuberculosis.

TUBERCULOSIS

For years the diagnosis of tuberculosis has been made on examination of the patient, bearing in mind the history of the case and supplementing the findings with an x-ray diagnosis, and perhaps a few clinical tests such as blood picture, Wassermann and tuberculin. A long period of treatment then ensued. If the patient was cured with function, the diagnosis was always questioned by some one sooner or later, and the surgeon treating the case was forced to admit that he could not prove the condition tuberculous.

Whether or not surgical procedures on these joints are justified purely for the sake of making a diagnosis is perhaps still in question, but an examination of the groups of cases listed here gives an idea of the wide variation at times found between diagnosis made solely on a physical examination and that on a pathological examination. The moderate discomfort ensuing after a biopsy done on a joint with careful surgical technique is little compared to the discomfort of years of fixation in a splint or plaster, particularly if the joint is not tuberculous and does not require such treatment, and the almost irreparable damage sometimes done by fixation with its resultant atrophy of bone and muscle and loss of joint function.

Of the 135 cases reported, 70 have been proven tuberculosis either by pathological section or by guinea pig inoculation. In many of these cases both biopsy and secondary operations have been done. In some of the cases of long standing disease with deformity, operation without biopsy has been done, hence a fair proportion of the cases have had bony tissue removed.

What are our methods of proving tuberculosis? The data is almost wholly dependent on (1) Examination of tissue removed at operation, (2) Guinea pig inoculation. Of the two methods, the first has been the more satisfactory. Are we justified in making a diagnosis of tuberculosis on pathological section? In this series those cases where we have felt any question about the picture presented have all been studied until conclusive evidence one way or another could be furnished. The simple presence of "tubercles" with giant cells can not be taken as evidence for tuberculosis

PROTOCOL

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
1	38	M	Knees, hips, elbows, hands	8 yrs.	Pain, stiffness, ankylosis with deformity, inability to walk	Chronic infectious arthritis	Extensive destruction. Probably arthritis		99	Arthroplasty	+ + +	Neg.		Chr. Inf.		Chronic arthritis
2	50	M	Hip	6 yrs.	Pain, deformity, stiffness	Chronic arthritis	Marked deformity head of femur		99	Arthroplasty		Neg.		Chr. Inf.	Chr. arth.	Chronic arthritis
3	17	F	Hip	13 yrs.	Fall with injury; pain, abscess, deformity	Tbc. hip, old	Head partly destroyed, irregularity of acetabulum. Tbc. hip	Hb. 70% Rbc. 4560000 Wbc. 7.800 Polys. 61%	99	1922: Arthrodesis 1924: Arthrodesis			Pos.	Tbc.	Tbc.	Tuberculosis
4	47	F	Shoulder	27 yrs.	Pain first, year duration Quiescent 20 yrs. Fall, pain, loss motion Treated as arthritis 6 yrs.	Chronic arthritis	(1) Arthritis (2) Old Tbc.		98.6	Arthrodesis	+ + +	Neg.		Chr. Inf.	Tbc.	Tuberculosis
5	7	F	Knee	4 yrs.	Pain, loss motion, limp, flexion	Tuberculosis	Tuberculosis		99	Arthrodesis	+ +			Tbc.	Tbc.	Tuberculosis
6	12	F	Shoulder	3 wks.	Loss motion, pain after exertion	? Tuberculosis	Findings consistent with Tuberculosis		99.6	Arthrodesis		Neg.		Tbc.	Tbc.	Tuberculosis
7	14	F	Knee	1 mo.	Pain (one month) Swelling (3 wks.) Flexion deformity	? Tuberculosis	Narrow joint space, soft tissue swelling	Hb. 80% Rbc. 4992000 Wbc. 5,400 Polys. 71%	99.6	(1) Biopsy (2) Arthrodesis	++++	Neg.	Neg.	Tbc.		Tuberculosis
8	22	M	Hip	3 yrs.	Strain 3 yrs. ago, recovery Strain 6 mos. ago Pain, stiffness, deformity since	? Tuberculosis	Destructive process	Wbc. 6,600 Polys. 71%	98.6	Arthrodesis	++++	Neg.		Tbc.	Tbc.	Tuberculosis
9	20	F	Hip	4 yrs.	Fall, with injury Pain, limp, abscess, deformity	Tuberculosis	Old Tuberculosis		100	Arthrodesis		Neg.		Chr. Inf.		? Tbc. or Osteomyelitis
10	45	F	Hips, knees, hands	10 yrs.	Neisser infection, followed by multiple joint pain and disability Positive smears from urethra	Gonorrhoeal arthritis	Chronic arthritis		100	Osteotomy to correct deformity of ankle		Neg.		Chr. Inf.		Chronic arthritis ? G.C.
11	4	F	Hip	3 mos.	Limp, pain, limitation of motion, flexion deformity	? Tuberculosis	Very early process in hip		100	Biopsy	+ +	Neg.	Pos.	Tbc.		Tuberculosis
12	38	M	Hip Spine	5 yrs.	Pain and stiffness hip and spine	Chronic arthritis	Arthritis, probably infectious		98	Arthrodesis		Neg.		Chr. Inf. process		Chronic arthritis

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
13	18	M	Knee	5 yrs.	Injury Pain, intermittent Slight flexion	? Internal derangement ? Tuberculosis	No variation from normal		98.6	Excision external semi-lunar Biopsy		Neg.	Neg.	Chr. Inf. process		Internal derangement
14	7	M	Hip	3 yrs.	Injury, 3 yrs. ago Pain few weeks. Slight disability and limp Injury 3 weeks Increased pain and limp Deformity	Fracture or epiphyseal separation	Slightly more radiability Bone atrophy		100	Biopsy	++++	Neg.	Pos.	Tbc.		Tuberculosis
15	13	F	Hip	1 yr.	Pain, limp Limited motion	? Injury ? Tuberculosis	Destructive process left hip		99	Biopsy	Neg.	Neg.	Dead 9 days	Chr. Inf.	Chr. Inf. non-Tbc.	Arthritis ? traumatic
16	10	F	Knee	6 yrs.	Pain following injury Disability Quiescent 4 yrs. Recurrence pain	? Tuberculosis	Tuberculosis		100	Biopsy	++++	Neg.	Neg.	Chr. Inf.		? Arthritis or Tuberculosis
17	38	F	Knee	7 yrs.	Pain following injury Treated as arthritis 3 years Recurrence. Pain, swelling, limited motion	? Tuberculosis	Obliteration of joint space. Irregularity in bone		98.6	Arthrodesis	+ +	Neg.	Pos.	Chr. Inf.		Tuberculosis
18	5	M	Hip	3 yrs.	Pain and disability Abscess. Deformity Loss of motion	? Tuberculosis	Bones more radiant than normal		100.5	Biopsy	+ + +	Neg.	Pos.	Tbc.		Tuberculosis
19	23	F	Knee	18 mos.	Fall, with injury to knee Pain, swelling, stiffness	? Tuberculosis	Chronic synovitis		98.6	Arthrodesis				Tbc.	Tbc.	Tuberculosis
20	11	F	Sacro-iliac	6 wks.	Pain down back of thigh Abscess in iliac fossa	? Tuberculosis	Sacro-iliac Disease		101	Drainage Biopsy	+ +	Neg.	Dead 1 week	Acute Inflam. process	Acute Inflam. process	Osteomyelitis ilium
21	7	F	Knee	5 yrs.	Injury Two months later swelling Pain Quiescent 4 yrs. Recurrence of pain and loss of motion	Tuberculosis	No positive evidence of tuberculosis in bone ? Tbc. Synovitis		100.5	Arthrodesis				Tbc.	Tbc.	Tuberculosis
22	38	M	Elbow	2 yrs.	Pain, stiffness, swelling Sinuses draining	? Osteomyelitis ? Tuberculosis	Infectious process		99.4	Arthrodesis			Dead 4 days			? Tbc.

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
23	25	F	Shoulder	6 yrs.	Pain, stiffness, atrophy Sinuses draining	Tuberculosis	Suggests Tbc.		99	Arthrodesis		Neg.		Tbc.	Tbc.	Tuberculosis
24	7	F	Wrist	4 mos.	Injury. Swelling five days later Pain, limited motion Diagnosed sprain twice Fracture once	? Tuberculosis	Old injury	Wbc. 6,400	98.6	Biopsy		Neg.	Neg.	Tbc.		Tuberculosis
25	27	F	Hip	21 yrs.	Pain right hip Treated with braces six years "Cured" Six months ago pain knee, stiffness	Tuberculosis	Old Tuberculosis of hip		99	1922 Arthrodesis 1924 Arthrodesis 1925 Arthrodesis				Tbc.		Tuberculosis
26	56	M	Hip	4 yrs.	Pain and stiffness Cleared up Past 3–4 months recurrence pain, limited motion, flexion	Arthritis	Narrowing of joint space		99	Arthrodesis			Pos.	Tbc.		Tuberculosis
27	9	M	Hip	3 yrs.	Injury from fall Two months later limped Sinuses formed and healed Limp. Pain	Tuberculosis	Marked destruction Tuberculosis		99	Arthrodesis	++++	Neg.	Neg.	Chr. Inf. process		? Tuberculosis
28	27	F	Knee	1 yr.	Injury three times, followed by disability 2 or 3 months Last injury 2 months ago	Tuberculosis	Longstanding destructive process		99	Arthrodesis		Neg.		Chr. Inf. process	Tbc.	Tuberculosis
29	16	F	Hip	10 yrs.	Treated 11 yrs. at Children's Hosp. with splint for Tbc. Flexion. Limited motion Limp	Old Tbc. hip	Destructive process No definite evidence of Tbc.		100	Arthrodesis				Chr. Inf. process		? Tuberculosis
30	25	M	Hip	23 yrs.	Fall at age of 2. Limp No treatment Flexion, adduction, limp	Old pathological dislocation	Old pathological dislocation Most probably Tbc.		98.6	Arthrodesis				Chr. Inf. process	Tbc.	Tuberculosis
31	18	M	Hip	18 yrs.	Probably congenital dislocation Flexion Limitation of motion	Osteochondritis right hip			98.6	Arthroplasty		Neg.		Chr. Inf. foreign body in joint.		Osteochondritis

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
32	16	M	Multiple	3 mos.		? Tuberculosis	Low-grade infectious process	Hb. 90% Rbc. 5200000 Wbc. 8.400 Polys. 64%	100	Biopsy	+	Neg.	Pos.	Tbc.		Tuberculosis
33	32	M	Knee	2 mos.	"Struck knee" Swelling 2 days later Pain. Rested with improvement. Recurred on exertion Swelling Fluid. Local heat	Osteochondritis dissecans	Air injection Loose body in joint		98.6	(1) Biopsy Removal loose body (2) Arthrodesis	+ +	Neg.	Neg.	Tbc.	Tbc.	Tuberculosis
34	30	M	Ankle	5 mos.	Injury. Pain Stiffness	Infectious arthritis	Arthritis		98.6	Arthrodesis		Neg.		Chr. Inf.		Chronic arthritis
35	30	F	Knee	3 mos.	Injury. Slight pain Swelling	Internal derangement. ? Tbc.	? Detached cartilage		99	Excision of cartilage				Chr. Inf.		Internal derangement
36	40	M	Knee	1 mo.	Pain, swelling, limited motion Followed G.C. urethritis	Gonorrhoeal arthritis	No definite variation from normal		99	Synovectomy		Neg.		Acute Inf.		Neisser arthritis
37	15	M	Knee	7 yrs.	Onset followed fall Treated 5 yrs. with plaster at Children's Hosp. Recurred following fall Stiffness, pain, limp	Tuberculosis	Longstanding disease, probably Tuberculosis		99	Arthrodesis		Neg.		Chr. Inf. process	Tbc.	Tuberculosis
38	46	M	Knee	6 mos.	Injury Pain at night, swelling Slight limitation of motion	Loose internal semilunar	Nothing definite made out		98.6	Biopsy			Neg.	Neg. for Tbc.		Internal semilunar
39	39	M	Knee	10 mos.	Injury Pain at intervals Swelling	Osteochondritis dissecans	Loose body in joint		98.6	Removal loose body			Neg.	Chr. Inf. Loose body		Osteochondritis dissecans
40	64	F	Hips	8 yrs.	Gradually increasing pain and limitation of motion	Chronic arthritis	Arthritis, infectious type		99	Arthroplasty		Neg.	Neg.	Chr. Inf.		Chronic arthritis
41	23	M	Ankle	2 yrs.	Injury Pain, limitation of motion Swelling	? Tuberculosis			99	Biopsy Amputation	Neg.	Neg.		Chr. Inf.	Tbc.	Tuberculosis
42	35	M	Knee	3 yrs.	Slight pain and limp Last 3 wks. marked pain with swelling and limitation of motion	Tuberculosis	Destructive process proliferative changes against Tbc.	Hb. 80% Wbc. 6.900 Rbc. 5410000 Polys. 65%	99	Arthrodesis	++++	Neg.	Pos.	? Tbc.		Tuberculosis

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
43	26	M	Shoulder	12 yrs.	12 yrs. ago pain; subsided Quiescent until 3 wks. ago Pain and limited motion Atrophy	Chronic arthritis	Destructive process consistent with Tbc.		99.2	Arthrodesis				Tbc.	Tbc.	Tuberculosis
44	20	F	Knee	9 mos.	Pain, limp. Worse past ten days. Fluid. Limited motion	? Internal derangement	No definite variation from normal		99	(1) Synovectomy (2) Arthrodesis		Neg.	Pos.	Tbc.	Tbc.	Tuberculosis
45	25	M	Knee	5 yrs.	Injury Pain, limited motion Abscess	Old septic joint	Destructive process not typical of Tbc.		99.6	Arthrodesis	+ + +	Neg.	Neg.	Tbc.		Tuberculosis
46	14	F	Knee	1 mo.	Acute pain, swelling Fluid. Limited motion	? Gonorrhoeal arthritis	Soft part swelling	Wbc. 15.300 Polys. 84%	100	Synovectomy	Neg.	Neg.	Dead 3 wks.	Acute Inf. process		Gonorrhoeal arthritis
47	25	M	Shoulder	3 yrs.	Injury Pain, limited motion	? Tbc. shoulder	Bone atrophy		99	Arthrodesis		Neg.		Subacute arthritis		? Tbc. or arthritis
48	7	M	Knee	2 yrs.	Injury Swelling, limited motion	? Tbc.	Swelling of soft parts		98.6	(1) Biopsy (2) Arthrodesis	++++	Neg.	Neg.	Tbc.		Tuberculosis
49	13	M	Knee	9 yrs.	Injury Pain and limited motion since Knee in valgus and flexed	? Tbc.	Old injury		100	(1) Biopsy (2) Fusion		Neg.	Neg.	Chr. Inf. process		? Tbc. ? Chr. Inf.
50	49	F	Ankle	4 mos.	Injury Pain, limited motion	? Tbc	Area of diminished density in scaphoid	Hb. 80% Rbc. 5650000 Wbc. 8,000 Polys. 61%	98.6	Excision of scaphoid	+ + +	Neg.			Giant cell tumor	Giant cell tumor
51	21	F	Ankle	15 yrs.	"Sprain." Injury 15 yrs. ago. Plaster 2 mos., crutches 1 yr. All right until 2 mos. ago. Recurrence, pain, swelling, stiffness	Old injury Arthritis Subastragaloid joint	Old injury with probable ankylosis		99	(1) Biopsy (2) Amputation	+ +	Neg.	Pos.	Tbc.		Tuberculosis
52	35	M	Hip spine, shoulders	6 yrs.	Pain and stiffness of back Pain in hip past 2 yrs.	? Tbc. ? Chr. arthritis	Destructive arthritis	Hb. 85% Rbc. 4890000 Wbc. 10.600 Polys. 62%	99	Arthroplasty		Neg.		Chr. Inf.		Arthritis
53	24	F	Hip	16 yrs.	Injury Pain, limited motion Operation. Quiescent Recurred 1 yr. ago. Pain, limited motion abscess Deformity	Tuberculosis	Pathological dislocation		99.8	Arthrodesis		Neg.		Chr. Inf.	Chr. Inf.	? Tbc.

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
54	12	F	Hip Shoulder	9 yrs.	Pain r. shoulder with stiffness. 1 yr. later pain in hip. Treated at Children's Hosp. six years. Quiescent. 3rd recurrence of pain and limp	? Tbc.	Probably Tuberculosis		99	Biopsy	++++	Neg.	Neg.	Tbc.		Tuberculosis
55	14	F	Hip	5 yrs.	Pain, limitation of motion 5yrs. Brace treatment Abscess	Tuberculosis	Tuberculosis	Wbc. 8,000 Polys. 72%	98.6	Arthrodesis	+ + +	Neg.		Tbc.		Tuberculosis
56	4½	M	Knee	18 mos.	Pain, swelling Previous operation said to show Tbc.	? Tbc.	Infectious process May be Tuberculosis	Wbc. 12,000	100	Drainage and Biopsy	+ +	Neg.		Chr. Inf.		? Tbc.
57	36	F	Hip	20 yrs.	Injury 20 yrs. ago, followed by infection	Old septic hip	Old arthritis		99	Arthrodesis		Neg.		Chr. Inf.		? old septic hip ? Tuberculosis
58	13	M	Knee	5 wks.	Fall, injury Swelling, limitation of motion Pain Later, same condition other knee	? Tbc.	Thickening of soft tissues. No bone changes		99	Biopsy	++++	Neg.		Chr. Inf.		? Synovitis ? Tbc.
59	41	M	Knee	10 yrs.	Pain, swelling Intermittent drainage Limited motion	? Tbc.	Infectious process		98	Arthrodesis		Neg.	Neg.	Tbc.		Tuberculosis
60	22	F	Hip	2 wks.	Pain, limited motion G.C. urethritis	Septic hip	(1) Negative (2) Destructive process	Wbc. 17,000	100	Biopsy	+ + +	Neg.	Neg.	Chr. Inf.		Gonorrhoeal Arthritis
61	33	M	Ankle	9 mos.	Intermittent pain and swelling for 6 mos. Sinus past 3 mos.	Tuberculosis	May be Tuberculosis		100	Amputation		Neg.			Tbc.	Tuberculosis
62	21	M	Knee	15 yrs.	Fell, injuring knee at age of 6 Pain on exertion and swelling since 4 yrs. quiescent Limited motion	Tuberculosis	Tuberculosis		98.6	Arthrodesis		Neg.	Pos.	Chr. Inf.		Tuberculosis
63	16	F	Hip	12 yrs.	Pain, limited motion Casts and braces 8 yrs. Abscess 2 yrs.	Tuberculosis with sepsis	Tuberculosis		103	Arthrodesis	+ + +	Neg.	Dead 3 wks.	Tbc.		Tuberculosis
64	39	M	Knee	5 yrs.	Injury Pain, swelling Biopsy at another hospital showed Tbc.	? Tbc.	Narrow joint space, thickened synovia		98.6	Arthrodesis			Pos.	Tbc.		Tuberculosis

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
65	18	F	Ankle	3 yrs.	Sprained ankle Pain 10 mos. 1 yr. later injured knee. 4 mos. of pain Swollen. Limited motion	? Tbc. or Osteomyelitis	Atrophy No fracture or infection	Hb. 90% Rbc. 5600000 Wbc. 9,400 Polys. 84%	99	Amputation		Neg.	Pos.	Tbc.		Tuberculosis
66	27	F	Tendon, sheath, hands	6 yrs.	Pain, swelling, limitation of motion	Tbc. tendon sheaths	Negative		99	Excision tendon sheath		Neg.	Dead 2 wks.	Chr. Inf. process		Tenosynovitis non-tuberculous
67	14	F	Hip and sacro-iliac	4 yrs.	Pain, limited motion Abscesses	? Tbc.	Probably Tbc.	Wbc. 14,600 Polys. 80%	99	Drainage Biopsy	Neg.	Neg.	Neg.	Chr. Inf. process		Osteomyelitis pelvis and femur
68	13	M	Hip	10 yrs.	Pain in knee, lameness on exertion Night cries	Acute epiphysitis (original diagnosis)	Probably Osteomyelitis		99	Arthrodesis	+ +		Pos.	Tbc.		Tuberculosis
69	24	F	Ankle	8 wks.	Pain, swelling, limitation of motion	Tbc.	?	Positive G.C. complement fixation	99	Drainage		Neg.		Chr. Inf.		Gonorrhoeal Arthritis
70	6	F	Knee	1 yr.	Pain, swelling, limitation of motion	? Tbc.	Tuberculosis	Wbc. 8,600	99.6	(1) Biopsy (2) Arthrodesis	++++	Neg.	Neg.	Tbc.		Tuberculosis
71	31	M	Hip	23 yrs.	Pain, limp Conservative treatment 1 yr. Quiescent 20 yrs. Recurrence. Abscess. Pain	Old Tbc.	Old Tbc. hip	Hb. 85% Wbc. 9,400	99	Amputation	++++	Neg.			Tbc.	Tuberculosis
72	17	M	Hips, shoulders, ankles	4 yrs.	Pain, swelling Sinuses draining over hip	Osteomyelitis	Osteomyelitis		99	Excision hip		Neg.		Chr. Inf.	Chr. Inf.	Osteomyelitis
73	20	F	Knee Wrist	5 yrs.	Swelling, pain	Tbc.	?		98.6	Synovectomy		Neg.	Neg.	Chr. Inf.	Chr. Inf.	Arthritis
74	14	M	Knee	1 mo.	Swelling. No pain	Prepatellar Bursitis	Negative		99	Excision of bursa		++++	Neg.	Chr. Inf.		Prepatellar Bursitis
75	32	M	Spine Sacro-iliac Wrist	3 yrs.	Pain, limp, swelling Drainage	Multiple Tbc. lesions	Destructive process		99	Arthrodesis	++++	++++	Pos.			Tuberculosis Lues
76	10	F	Ankle	3 yrs.	Slight pain. Limp	Tbc.	Localized abscess or osteomyelitis		99	Biopsy	Neg.		Neg.	Cyst		Bone cyst

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
77	9	M	Knee	3 yrs.	Pain, swelling, limited motion Healed sinuses Subluxation	Tbc.	Probably old Tbc.		98	Arthrodesis				Chr. Inf.		? Tbc.
78	23	M	Wrist	8 yrs.	Intermittent pain, swelling ("Ganglion" excised 3 years ago)	? Tbc.	Infectious process May be Tbc.		98	(1) Biopsy (2) Excision	++++	Neg.	Neg.	Tbc.	Tbc.	Tuberculosis
79	25	F	Hip	18 yrs.	Pain, limp, flexion and adduction deformity	Old Tbc.	Destructive process	Hb. 85% Wbc. 8,000 Rbc. 5400000	99	1919 Arthrodesis 1925 Arthrodesis	++++	Neg.		Chr. Inf.	Tbc.	Tuberculosis
80	8	F	Hip	7 yrs.	Injury at 9 mos. Limp. Deformity	Tbc.	Destructive process		99.6	Arthrodesis	Neg.	Neg.	Neg.	Chr. Inf.		Old injury ? Tbc.
81	14	M	Knee	1 yr.	Injury. Stiffness, swelling Increased heat	Tbc.	Soft tissue swelling		99	Arthrodesis	+ + +	Neg.		Chr. Inf.		? Tbc.
82	18	M	Hip	8 mos.	Injury 8 yrs. ago Pain, limited motion Limp	? Tbc	Atrophy		99.6	Biopsy	+	Neg.	Neg.	Chr. Inf.		Arthritis ? Tbc.
83	20	M	Knee	1 yr.	Injury Pain, swelling, lameness	Tbc.	Soft tissue swelling		98.6	Arthrodesis		Neg.	Pos.	Tbc.		Tuberculosis
84	35	F	Spine	1 yr.	Pain right hip Swelling over lumbar region Cold abscess	Tbc.	No definite evidence of pathology	Hb. 70% Rbc. 4298000 Wbc. 13,000 Pmn. 80%	99	Drainage		Neg.	Pos.			Tuberculosis
85	9	M	Knee	3 wks.	Injury Slight limp. Pain	? Tbc.	Soft tissue swelling		100	Biopsy	Neg.	Neg.	Neg.	Chr. Inf.		Synovitis, traumatic ? Tbc.
86	12	M	Hip	2 mos.	Pain in knee after exertion Swelling about hip	Septic hip (subacute)	Irregularity of epiphysis	Wbc.10,000	99	(1) Aspiration (2) Arthrodesis	++++	Neg.	Pos.	Tbc.	Tbc.	Tuberculosis
87	18	F	Hip	14 yrs.	Pain, limp, deformity 5 yrs., free of symptoms Recurrence	Old Tbc. hip	Tuberculosis		98.6	Arthrodesis	++++	Neg.	Pos.	Chr. Inf.		Tuberculosis
88	27	F	Hip	25 yrs.	Pain, limp, deformity	Old Tbc. hip	Tuberculosis		98.6	Arthrodesis			Pos.			Tuberculosis
89	15	F	Shoulder	16 mos.	Pain at night Limitation motion	Tbc.	Epiphysitis, may be Tuberculosis	Wbc. 7,800 Pmn. 80%	99	Arthrodesis	Neg.			Chr. Inf.		? Tbc.

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
90	25	M	Knee	6 yrs.	Injury. Six months Later limp, intermittent since Severe 3 mos.	? Tbc.	Suggests Tbc.		99.6	Arthrodesis		Neg.	Neg.	Tbc.		Tuberculosis
91	23	M	Knee	1 yr.	Injury Intermittent pain and swelling since	Osteochondritis dissecans	Irregularity condyle femur		99.6	Arthrotomy	++++	Neg.		Chr. Inf.		Osteochondritis dissecans
92	38	M	Knee	8 yrs.	Old injury Quiescent Recurrence 1 yr. Pain, limp	Chronic arthritis, infectious	Hypertrophic changes		99	Synovectomy		Neg.	Neg.	Chr. Inf.		Arthritis (Infectious)
93	10	F	Knee, spine	5 yrs.	Quiescent Tbc. spine Pain. Subluxation knee	Tuberculosis	Old infectious process		100	Arthrodesis	Neg.	Neg.	Pos.	Tbc.		Tuberculosis
94	16	M	Hip, spine	7 yrs.	Pain in knee on walking. Splints 4 yrs. Flexion deformity	Tbc.	Tuberculosis		99	Arthrodesis, hip Fusion, spine		Neg.		Chr. Inf.		? Tbc.
95	7	M	Ankle	3 wks.	Pain, limp, swelling Abscess	? Tbc.	Soft tissue swelling Bone atrophy	Wbc. 12,800 Hb. 90%	100	Biopsy Arthrodesis	+ + +	Neg.	Pos.	Tbc.	Tbc.	Tuberculosis
96	15	M	Knee	11 yrs.	Injury. "Operation" 3 days later Pain, loss motion, deformity	? Tbc.	Suggests old Tbc.	Wbc. 16,000	99.6	(1) Biopsy (2) Arthrodesis	+ + +	Neg.	Neg.	Tbc.		Tuberculosis
97	18	F	Knee	4 yrs.	Onset gradual Pain, limp. 2yrs. treatment in plaster. "Well." Recurrence, pain, deformity, limp	Tbc.	Soft tissue swelling		99.6	Arthrodesis	+ +	Neg.	Pos.	Tbc.	Tbc.	Tuberculosis
98	29	M	Elbow	5 mos.	Gradual onset. Pain, limited motion, swelling	Tbc.	Destructive process infectious in origin		100	Arthrodesis	++++	Neg.		Tbc. or Lues	Tbc.	Tuberculosis
99	31	M	Hip	2 yrs.	Pain knee, limited motion Deformity	Tbc.	Acute process more than Tuberculosis	Wbc. 8,000 Hb. 75%	99	Arthrodesis		Neg.	Pos.	Tbc.		Tuberculosis
100	19	M	Knee	2 yrs.	Pain, limitation Operation, better Recurrence after 1 yr. with deformity	? Tbc.	Very suggestive of Tuberculosis		98.6	Arthrodesis		Neg.		Tbc. or Lues	Tbc.	Tuberculosis

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
101	35	M	Hip	2 yrs.	Pain, acute Loss of motion Abscess	Septic hip, old	No evidence of destruction		100	Arthrodesis	Neg.	Neg.	Neg.	Chr. Inf.		Septic hip
102	18	M	Ankle	4 yrs.	Sprain Pain intermittent	? Tbc.	Brodie's Abscess	Wbc. 11,800	98.6	Drainage		Neg.	Neg.			Brodie's Abscess
103	27	F	Ankle	5 mos.	Injury. Pain later Swelling, 3 wks. duration	? Gonorrhoea ? Tbc.	Infectious process	Wbc. 14,400 Pmn. 92%	99	Biopsy		Neg.	Pos.	Tbc. or Lues		Tuberculosis
104	4	F	Hip	1 yr.	Pain, limp, deformity Abscess	? Tbc.	? Tuberculosis		100	Drainage	Neg. Positive after transfusion	Neg.	Pos.			Tuberculosis
105	26	M	Knee	2 yrs.	Gradual onset, pain, intermittent Swelling. Deformity	? Tbc.	Appearance quite different from Tbc.		98.6	Arthrodesis	+ +	Neg.	Neg.	Tbc.		Tuberculosis
106	26	M	Ankle	4 yrs.	Multiple joints at first following G.C. arthritis Treated with vaccine Ankle remained painful and stiff	Gonorrhoeal Arthritis	Destructive process		99	(1) Biopsy (2) Amputation			Neg.	Tbc.		Tuberculosis
107	16	M	Hip	2 wks.	Pain in hip and right lower quadrant	Pelvic abscess ? Tbc. hip	Infectious process, most likely Tbc.			(1) Biopsy (2) Arthrodesis			Neg.			? Tbc.
108	49	F	Knee	5 mos.	Pain, swelling, limited motion "Locking"	Osteochondritis dissecans	Suggests osteochondritis dissecans		99	Synovectomy				Chr. Inf.		Arthritis
109	24	F	Knee	1 yr.	Injury. Stiff knee since Pain. Swelling	? Tbc.	Swelling soft parts	Wbc. 11,000 Pmn. 80%	99	Arthrodesis	+ + +	Neg.	Neg.	Chr. Inf.		? Tbc.
110	37	M	Shoulder	4 yrs.	Injury. Pain and stiffness since	? Tbc.	Tbc. or Charcot, favors latter	Wbc. 6,800	99	Arthrodesis	+ + + +	Neg.	Pos.	Tbc.		Tuberculosis
111	19	M	Knee	11 yrs.	Pain, limp, swelling Quiescent 8 yrs. Recurrence 1 week	? Tbc.	? Tbc.		99.6	Arthrotomy	+ +	Neg.	Neg.			? Tbc.
112	16	M	Trochanter	5 yrs.	Pain over trochanter Intermittent	Osteomyelitis	May be old trauma or infectious process	Wbc. 8,800	98.6	Excision	Neg.	Neg.	Pos.	Chr. Inf.		Tuberculosis
113	23	M	Ankle	5 yrs.	Pain, stiffness Operation Recovery	? Tbc. ? Osteomyelitis	Osteomyelitis		98.8	Drainage		Neg.	Neg.	Chr. Inf.		? Tbc.

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
114	14	F	Hip	2 yrs.	Pain in knee Limited motion	Slipped epiphysis	Destructive process	Wbc. 8,400 Pmn. 71%	99	Arthrodesis	++++	Neg.	Pos.	Chr. Inf.		Tuberculosis
115	16	F	Hip	2 wks.	Pain. Limitation motion Slight swelling	? Septic hip ? Tbc.	Infectious process	Wbc. 6,800 Pmn. 65%	102	(1) Biopsy (2) Arthrodesis		Neg.		Chr. Inf.		? Tbc.
116	19	M	Hip	10 mos.	Injury. 2 mos. later stiffness	? Tbc.	Old infectious process	Hb. 85% Wbc. 9,000 Pmn. 52% Rbc. 5250000	99	Biopsy	Neg.	Neg.		Chr. Inf.		? Tbc.
117	60	M	Spine	8 wks.	Pain. Limited motion Pelvic abscess	? Tbc.	Hypertrophic changes	Wbc. 22,500 Pmn. 74%	103	Drainage Biopsy	Neg.	Neg.		Chr. Inf.		Probably osteomyelitis
118	21	M	Hip	15 yrs.	Pain. Limited motion Deformity Draining sinuses	Tbc.	Old Tbc.		102	Arthrodesis	Neg. + after transfusion	Neg.		Chr. Inf.	Tbc.	Tuberculosis
119	65	M	Knee	2 yrs.	Swelling, pain. Limitation motion	Arthritis	Thickened capsule Hypertrophic changes		99	(1) Synovectomy (2) Arthrodesis	++++	Neg.	Pos.	Tbc.	Tbc.	Tuberculosis
120	43	M	Knee	10 yrs.	Injury. Few weeks later pain on exertion Swelling lately	Tbc.	Destructive process		99	Arthrodesis		Neg.	Neg.	Chr. Inf.		? Tuberculosis
121	13	F	Hip, shoulder	2 yrs.	Pain, swelling High fever at first Drained several times	Osteomyelitis	Destructive process, probably infectious	Wbc. 18,000	102	Excision head	Neg.	Neg.		Chr. Inf.	Chr. Inf.	Osteomyelitis
122	21	F	Knee	3 mos.	Pain, swelling, limited motion	Gonorrhoeal Arthritis	Soft part swelling	Wbc. 13,600 Pmn. 65%	99	Synovectomy	+ +	Neg.	Pos.	Chr. Inf.		Tuberculosis
123	31	F	Knees, hands, elbows	8 yrs.	Gradual onset; pain, stiffness	Chronic arthritis	Arthritis, destructive type		99	Synovectomy	Neg.	Neg.	Neg.	Chr. Inf.		Arthritis
124	41	M	Elbow	14 yrs.	Swelling, pain Operation: drainage 1½ yrs. Quiescent until 4 months ago	? Tbc.	Not characteristic of Tbc.		99	Arthrodesis	++++	Neg.		Tbc.		Tuberculosis
125	11	M	Ankle	2 mos.	Injury Swelling, pain	? Tbc.	No definite evidence of disease		100	Biopsy			Lost	Chr. Inf.		? Tbc.

Case No.	Age	Sex	Joint	Duration	History	Pre-operative Diagnosis	X-ray	Blood	Temp.	Operation	Tuberculin	Wassermann	Pathology G.P.	Pathology Soft Tissue	Pathology Bone	Final Diagnosis
126	22	F	Ankle	7 mos.	Pain, limitation motion Treated with cast Subsided Recurred on walking Swelling and pain	? Tbc.	Extreme bone atrophy		99	(1) Biopsy (2) Amputation	+	Neg.	Pos.	Tbc.	Tbc.	Tuberculosis
127	18	F	Knee	5 wks.	Injury Two weeks later pain in knee	Acute arthritis, traumatic	Soft tissue swelling		102	Synovectomy			Neg.	Subacute inflam.		Arthritis
128	28	F	Elbow	10 yrs.	"Soreness." Slight limitation motion Operation. "Removal of tumor"	Infectious Arthritis	Suggests Tbc.		99	Fusion		Neg.		Tbc.		Tuberculosis
129	16	M	Knee	2 yrs.	Injury Pain, swelling since	Osteochondritis dissecans	? Loose body		98.6	Removal of loose body	+ +	Neg.		Chr. Inf.		Osteochondritis dissecans
130	31	M	Sacrum	5 mos.	Swelling, pain	"Tumor"	No definite evidence of disease	Wbc. 15,800 Pmn. 67%	100	Biopsy			Neg.	Angio-sarcoma		Angiosarcoma
131	22	F	Hip	14 yrs.	Old injury knee Pain since, limited motion. Deformity	Old Tbc.	Old destructive process, probably Tbc.		99	Arthrodesis				Chr. Inf.	Tbc.	Tuberculosis
132	28	M	Knee	6 mos.	Pain on weight-bearing	? Tbc.		Wbc. 7,600	98.6	Biopsy		Neg.	Neg.			? Tbc.
133	50	M	Knee	5 yrs.	Intermittent pain and swelling Clearing on anti-luetic treatment	? Tbc.	Spur formation		99	Biopsy	++++	++++		Lues ? Tbc.		Syphilis
134	36	M	Spine, elbow	1 mo.	Elbow healed, stiff Spine painful Abscess	Tbc.			102	Drainage Biopsy				Tbc.		Tuberculosis
135	14	M	Hip	6 yrs.	Injury Pain 1 wk. later Limitation motion Deformity Abscess	Tbc.	Old destructive process		100	Drainage			Neg.			? Tbc.

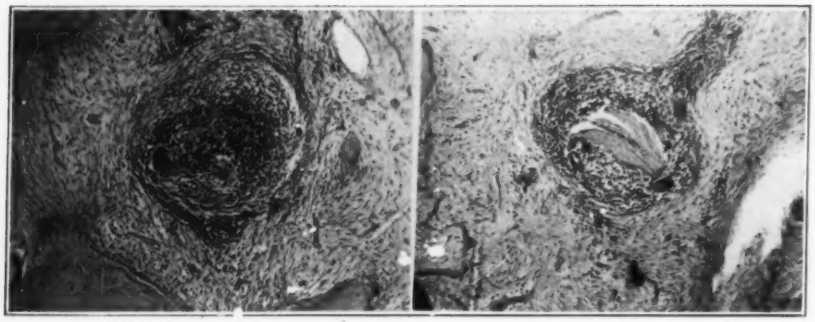


FIG. 1

Tubercle formation in a case of ununited fracture. Note giant cells, fragment of dead bone but no epithelioid cells.

as, for example, these tubercles on closer examination may be due to a foreign body reaction (Fig. 1). If, however, the tubercle is composed of the typical epithelioid cell (Fig. 2) with or without giant cell and lymphocyte, we have made a diagnosis of tuberculosis (Fig. 3).

TISSUE EXAMINATION

The tissue examination has been of two types: First,—soft parts, generally synovial membrane removed at biopsy and examined either at once by frozen section, or within a day or two in the laboratory of surgical pathology. Second,—study of bony tissue removed at operation, decalcified, and sectioned. The latter, of course, is a long drawn out procedure, taking generally two to three weeks. It is interesting to note, however, that in the cases where soft tissue only was examined there are six cases diagnosed non-tuberculous which had guinea pigs reported positive. Also, eight cases where a diagnosis of non-tuberculous inflammatory process or a question of lues was made, and later sections of bone removed showed unmistakable tuberculosis.

This indicates either: first, that the biopsy was faulty,—that is, that there was not enough tissue removed for a thorough study, or that it was chosen from an area of the joint not involved by tuberculosis; or, second, that the tuberculous process had not yet reached the soft parts of the joint and was confined solely to the bony structures.

In the procedure of biopsy or arthrotomy for diagnosis, where tuberculosis is suspected, it is necessary always to remove a generous supply of tissue from the suspected area of a joint. One rarely sees tubercles on gross examination at operation, and if tuberculosis is present in the soft parts and is not found at biopsy, the fault lies entirely with the surgeon who selects and removes the tissue, and not with the pathologist who examines it.

The studies by Nichols,[1] Allison,[2] etc., have shown that the predominance of tuberculosis is in the bony structures first, and in the soft tissues

of the joint second. This probably to a large extent explains the ten cases where biopsy failed to show the diseased tissue. We will make no effort in this paper to prove or disprove the question of synovial tuberculosis as a disease entity. The above mentioned fact is, however, of some significance along this line. That the duration of the disease may have some bearing on this is unlikely, as the shortest case of those proven by section to be tuberculosis was of three weeks' duration of symptoms. This case showed quite extensive involvement of the bony structures. The longest duration, twenty-seven years, likewise showed extensive involvement.

It has been in the long standing cases, particularly those invaded by the surgeon or by infecting micro-organisms of secondary nature, that the greatest difficulty has arisen. Here the disease picture is greatly modified. Healing of large areas takes place, but the tuberculosis remains latent in some portion of the involved structures. If we had a definite pathological picture of healed tuberculosis the task in these cases would be simplified. Certain it is that there are more or less characteristic changes that make us

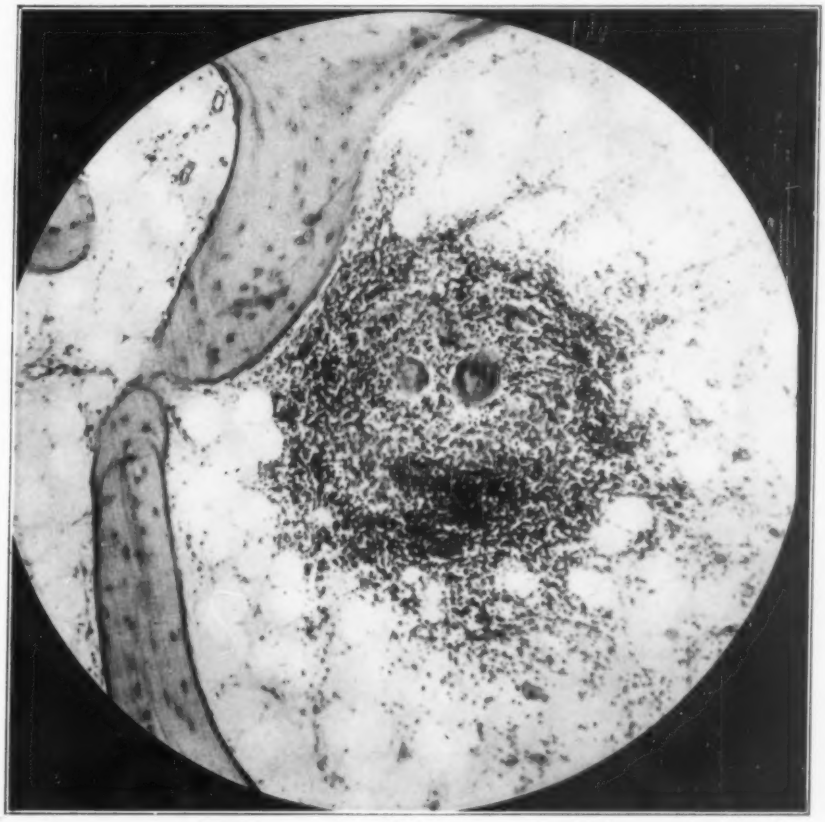


FIG. 2

Tubercle from a case of bone tuberculosis showing giant cells and epithelioid cells. Case 19.

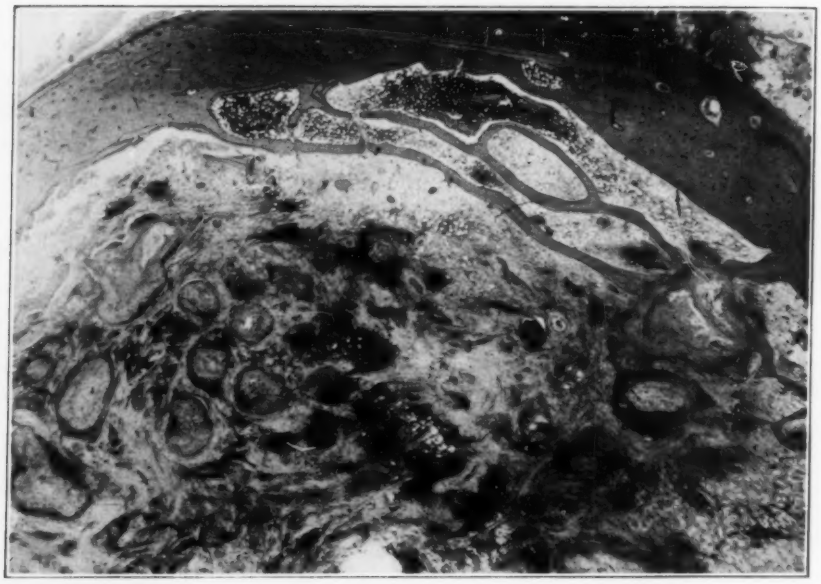


FIG. 3

Showing numerous epitheliod cell tubercles without giant cell formation. From a case of tuberculosis of shoulder. Case 23.

suspect tuberculosis, particularly the appearance of the cartilage. The work of Phemister[3] has thrown a great deal of light on this phase of the problem, but as yet we are not prepared to accept any picture of healed disease as characteristic of tuberculosis.

In these cases repeated sections have been made, and in some cases as many as four or five areas were examined before definite tuberculosis was found. For this reason, we feel that one is not justified in saying that tuberculosis exists in synovial membrane alone, as the possibility of discovering a small focus hidden away in the bony trabeculae is great.

GUINEA PIG INOCULATION

The wide variation between the number of positive guinea pig tests and positive tissue diagnoses is worthy of consideration. Only twenty cases where tissue was reported positive showed guinea pig inoculation to be positive. We have six cases where tissue report was negative and guinea pig positive. Later studies of tissue from these cases may show tuberculosis. There are five cases which had positive guinea pig reports, with no tissue examination. These were cases aspirated or drained without biopsy. The simple paracentesis of joints for material is not feasible in many cases, for, in our experience, as a rule only the very early cases have enough free fluid to aspirate easily, and not all of these early cases have any free fluid.

In eight cases, where material was injected, the guinea pig died "too soon for diagnosis". In most of these cases there was secondary infection

which predominated the material, and presumably caused infection in the guinea pig more rapid than the tuberculous infection.

The large group of cases with positive tissue diagnosis and negative guinea pig reports can perhaps be attributed to the intra-peritoneal route of inoculation used by our laboratory. On this point I quote a recent communication from Dr. A. K. Krause of Baltimore:

"With proper technique, the inoculation of guinea pigs with suspected material for the diagnosis of tuberculosis should, in my opinion, rank as high in reliability as any laboratory procedure which we have. Of course, the material to be inoculated must be in proper shape, and I also think that there are certain practical points which should be observed if you are to get the best results.

"Because the development of tuberculosis is a slow process and, therefore, animals may die before the four weeks or more necessary for the infection to become apparent, at least two guinea pigs should be inoculated with suspected material. I think that one great fault in routine inoculation is that it is so frequently done by the intraperitoneal route. It has long been known by workers in experimental tuberculosis that the peritoneum will frequently take care of minimal numbers of tubercle bacilli without apparent infection resulting and that, in this location, the guinea pig is apparently more resistant than by way of the subcutaneous tissue. In our laboratory we therefore always inoculate our animals subcutaneously into the loose tissue of the right groin which ordinarily will take care of at least 4 cc. of material. This avenue has another first-class advantage in that from about ten days to two weeks, or perhaps a little later, palpable changes of the regional lymph nodes begin to appear which, if they originate at about this time, are presumptive evidence of tuberculous infection. Outside of being certain that the material for inoculation has not been sterilized by preserving fluids, etc., and that it has all been put into the animal's body, there are relatively few precautions to take in the technique except to make sure that tissues are ground up or well macerated so that the bacilli are set free from the tissue in which they may otherwise be enclosed. Under the latter circumstance they may not be made available for the infection of the animal. I know from experience that an excessively small number of living virulent tubercle bacilli will practically always infect guinea pigs by the subcutaneous route. Of course, if the numbers of bacilli in the suspected material are excessively few, generalized infection of the guinea pig may develop with extreme slowness. In these circumstances, the animals may have to be allowed to live for several months if one is to detect infection."

HISTORY

In reviewing the histories of the cases of proven tuberculosis, one or two facts stand out prominently. First of all, injury. No doubt most writers on tuberculosis have given this factor due credit. The frequency of injury of rather trivial nature, followed in a few weeks or months by the onset of symptoms of ultimately proven tuberculosis, is worth more than passing notice. Are these cases of tuberculosis quiescent or incipient in the joint, activated by trauma, or are they cases where the tubercle bacillus in an individual with tuberculosis lodges in a point of lowered resistance; i.e., the injured joint or its adjacent bony structure? We are unable to answer this from our studies thus far.

Two cases, 59 and 106, gave perfectly typical histories of multiple joint infection followed by a mon-articular type, which ultimately proved to be tuberculosis. In both of these cases a diagnosis of gonorrhoeal

FIG. 4

Case 95. Shows slight bone atrophy. Sections showed invasion of head of astragalus by tuberculosis.

arthritis was made, each giving a history of specific urethritis. The presumption is that the tuberculosis was probably secondary, though the possibility of multiple tuberculosis," rheumatisme tuberculeuse," must be considered.

The long periods of quiescence noted in several cases are worthy of consideration, particularly as some of these cases had been considered *cured*. The question of a real cure in tuberculosis of joints where motion remains is probably a long way from being settled. Such cases should be labeled "arrested" rather than cured, until we can furnish proof of eradication of the disease.

As to duration of disease, only twelve of the cases have been under one year. Of the cases showing no tuberculosis in soft parts with tuberculosis of bone, one is of seven years' duration; the rest are of fourteen years' duration or over. This probably means that the bony tissues harbor the disease longer than the soft parts. The low proportion of cases under one year's duration again brings to our attention the ever important question of early diagnosis in tuberculosis.

X-RAY

The x-ray has come to be one of our greatest aids in the diagnosis of bone and joint disease. We place a great deal of reliance on it in most of our work. The study of the x-rays in these cases has shown one fact to be true, that there may be extensive bony involvement by tuberculosis without any appreciable change in the x-ray picture. Take as an example Case 95, the x-ray of which is presented in Figure 4. In this case the head

of the astragalus was found quite extensively involved by tuberculosis, and yet there is scarcely any perceptible change in the x-ray picture. True, it was an early case of only three weeks' duration, but it was a rapidly advancing case in which an immediate diagnosis was most important.

The only thing seen in the early cases may be atrophy, together with some thickening. The enlargement and squaring of epiphyses so often quoted as characteristic is not seen in these cases (Figs. 5 and 6). As the disease advances, the picture becomes more definite, with increased radiability of bone or diminution of lime salts, areas of irregularity along the joint line and in the bone. (Figs. 7 and 8). The later cases, especially those where secondary infection has been superimposed, or the surgeon has intervened, show wide variations from any constant picture. In our experience then, only cases fairly well advanced, without secondary infection or surgical intervention, have anything like a characteristic picture.

BLOOD STUDIES

It is unfortunate that we have not complete blood studies in all cases of tuberculosis. Most of those reported are but single counts, which may or may not be of value. A moderate grade of anaemia is usually present. In the cases with severe long standing sepsis, the anaemia has been more marked, probably due to this rather than to the tuberculosis *per se*. Of the cases presenting white blood counts of over 10,000, all but one had abscess formation with secondary infection.

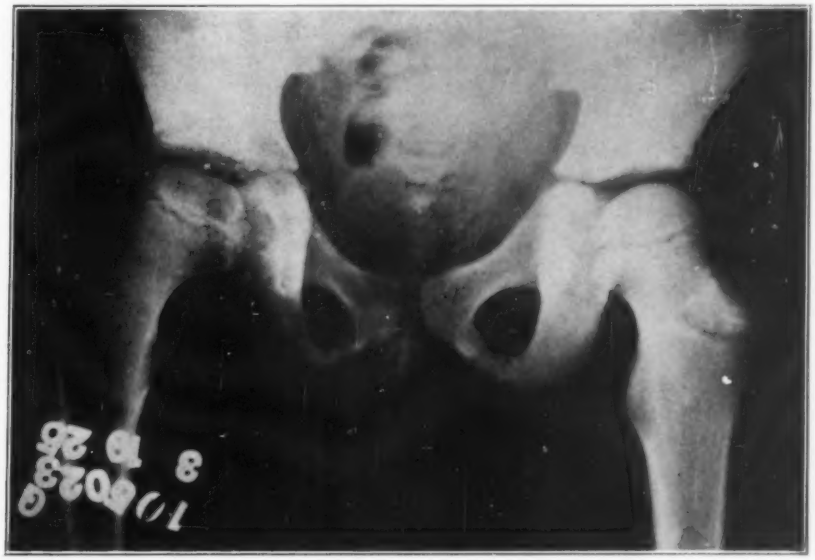


FIG. 5

Case 14. Tuberculosis of right hip of three years' duration. Shows slight amount of bone atrophy.

FIG. 6

Case 7. Shows tuberculosis of knee of three months' duration. No change in bone other than slight atrophy.

FIG. 7

Case. 8. Tuberculosis of hip of three years' duration. Disease in head of femur and acetabulum.

FIG. 8

Case 26. Tuberculosis of hip of four years' duration, showing atrophy: not much bone destruction.

TEMPERATURE

The temperatures have, of course, all been pre-operative on only a few days' observation. Seventeen cases had normal temperatures over this short period. The four cases with temperature over 100° had abscess formation. The remaining cases averaged 99–100° evening temperature.

TUBERCULIN

The tuberculin tests are not complete in the proven cases, forty-one out of the series having the reaction recorded. The intradermal test has been used in most cases. On a service with the house staff changing constantly, one would expect less uniform results than in places where an individual carried out the tests on a long series of cases.

Brown[4] states: "the value of diagnosis of these (tuberculin) tests is confined to the first few years of life. In adults they indicate only that tuberculous infection has occurred".

In the series of proven cases of tuberculosis the following results are noted:

TABLE 1

Tuberculin positive; tissue or guinea pig positive	38 cases
Tuberculin negative; tissue or guinea pig positive	5 cases
Tuberculin not recorded	31 cases

This compares with the non-tuberculous or questionable tuberculous groups as follows:

TABLE 2

Tuberculin positive; tissue negative	14 cases
Tuberculin negative; tissue negative	13 cases
Tuberculin not done; tissue negative	40 cases

In the latter group, six of the fourteen cases with positive tuberculin are questionable, that is, sufficient sections have not been made to prove them non-tuberculous.

While there is much discussion about the real value of tuberculin and its significance, the fact that only five cases with positive diagnosis showed negative reactions is notable. Three of these five were in cases septic and anaemic. Two of these showed positive reactions following transfusion. The other two are unexplainable, except that there may have been some fault in the technique.

The relative phases of the reaction are thoroughly discussed by Zinsser.[5]

WASSERMANN

The blood Wassermann was reported in 105 cases of the entire series. In only one of these, Case 75, was there tuberculosis with a positive Wassermann, and evidence of clinical syphilis was present. This same case was

proven tuberculosis by guinea pig. The other two positive Wassermanns will be discussed later. A moderately positive Wassermann is said to be found fairly often in tuberculosis. Our experience is not in accord with this.

A COMPARISON OF THE CLINICAL DIAGNOSIS WITH FINAL DIAGNOSIS

In the following table is presented a summary of the cases arranged to compare the clinical with the final diagnosis. We have differentiated as far as can be determined from our records those cases in which a clinical diagnosis of tuberculosis was made and those in which tuberculosis was questioned. In the latter group are cases in which the predominating evidence favored tuberculosis, yet there was not enough to justify such a preoperative diagnosis.

TABLE 3

Clinical Diagnosis Tuberculosis	41 cases	
Final Diagnosis Tuberculosis	27	66%
" " ? Tuberculosis	10	24%
" " other than Tbc.	4	10%
Clinical Diagnosis ? Tuberculosis	52 cases	
Final Diagnosis Tuberculosis	27	52%
" " ? Tuberculosis	15	29%
" " other than Tbc.	10	19%
Clinical Diagnosis other than Tuberculosis	42 cases	
Final Diagnosis Tuberculosis	16	38%
" " ? Tuberculosis	3	7%
" " other than Tbc.	23	55%

From the above table it is evident that where tuberculosis was diagnosed, the diagnosis was correct in 66% of the cases. If all of the cases where tuberculosis is questioned were proved to be tuberculosis, the correct diagnosis would have been made in 90% of the series.

Taking the group of cases with clinical diagnosis of questionable tuberculosis, we find that 52% of these proved to be tuberculosis. In 29% of the cases the question is still in doubt. In 19% the cases proved to be other than tuberculosis.

It is to be regretted that in so large a percentage of cases we are as yet unable to submit a final diagnosis. We can take as final in the two groups the diagnoses listed as other than tuberculosis. We have, therefore, clinically diagnosed tuberculosis where it did not exist in 15% of 93 cases.

If we turn to the third section of the table, those cases in which diagnosis of non-tuberculous disease was made, we find a much larger percentage of error, there being sixteen or about 38% of these proven tuberculosis. Such errors in diagnosis are even more serious than the tendency to diagnosis of tuberculosis where it does not exist. To a large extent they represent the most important of all our cases where biopsy has been of the greatest benefit.

EFFICACY OF BIOPSY

A summary of the cases in which biopsy was done for diagnosis shows that thirty-seven operations for diagnosis were made. Of these, nineteen or 50% on section of the tissue removed showed tuberculosis. Seven or 18% showed conditions other than tuberculosis. Twelve or 32% were reported as no "evidence of tuberculosis". This latter group of cases represents what may or may not be failure to convince ourselves of the condition. All were cases in the group of questionable tuberculosis, and in several there has been much doubt left as to the condition present. It is certain that in some a faulty selection of tissue was made. In three cases fusion was done in spite of the negative findings. Six of the cases are still under observation, with the same diagnosis as before operation. In the remaining three cases there is less question about the diagnosis.

While we feel a certain sense of disappointment in these figures, we must realize that at present biopsy is the best method we have for diagnosis, and has been of tremendous help in assuring ourselves of the presence of tuberculosis, yet there is need for a better method to be developed.

CONDITIONS OTHER THAN TUBERCULOSIS

In the group of osteochondritis dissecans, one case proved on biopsy to be tuberculosis. One was finally diagnosed arthritis with loose bodies, while three were quite typical of the above named condition. We know little of this condition as to its etiology, and it may be possible that more exhaustive studies on the pathology of the bones and joints and *not* of the loose bodies will help in clearing up the question of the etiology of this disease.

The cases listed with final diagnoses of arthritis have quite consistently been diagnosed the same before operation. The usual pathological pictures of the two great types of arthritis have been described by Nichols and Richardson.[6] Our findings have conformed with theirs. The x-rays, too, in these cases have been quite consistent in giving evidence favorable to a correct diagnosis. The occasional positive tuberculin reaction in these cases is to be expected in any similar group of cases.

Of the remaining cases which deserve special attention, Case 50, a giant-cell tumor of the tarsal scaphoid, is unusual. The clinical picture was entirely consistent with tuberculosis, the x-ray not at all suggestive of tuberculosis. The pathological picture was the usual one seen in such a condition.

The single case of proven syphilis of a joint was interesting, in that the patient had both a positive Wassermann reaction and a strongly positive tuberculin reaction. The tissue was not typical of either. Failure to stain tubercle bacilli in the tissue was suggestive. The most suggestive fact in the case has been its rapid healing under anti-luetic treatment since the biopsy was done. A clear pathological picture of synovial syphilis is not

well known. A case of prepatellar bursitis gave a positive Wassermann. The tissue showed chronic inflammation, no evidence of lues.

A single case of "Brodie's abscess" is reported. There was no evidence whatever of tuberculosis in the sections of this tissue.

The cases of gonorrhoeal arthritis all gave rather strong evidence, the organism being demonstrated in the joint fluid in one case. Positive complement fixation was found in one case. The pathology of the synovial membrane in the acute cases was characterized by large infiltration of all of the cells of the blood into the synovia, the polymorphonuclear leucocytes predominating. The tendency to regard acute single joints in adults as Neisser in origin is probably to a certain extent sound, but more conclusive evidence should be furnished. The organism should be found either in the joint fluid or in the membrane. The latter procedure is difficult, but can be accomplished.

SUMMARY

We have presented a series of cases of joint disease where an effort has been carried through to reach a final positive diagnosis. The predominating disease of the series is tuberculosis, because we feel that diagnosis in this is of prime importance. We have shown some of the difficulties in the way of making a positive diagnosis, even where biopsy has been performed. That we should discourage biopsy for this reason is far from our intent, for as we now stand it offers the surest means of diagnosis. The guinea pig test is of value, but in this series has not shown up well, probably on account of the method of inoculating the guinea pigs. Of the other available aids in diagnosis, the tuberculin test deserves first mention, a negative reaction being strongly against tuberculosis. The x-ray in the early cases is of little help, and in complicated cases is of little or no value except to show the extent of the disease. The history and physical examination are of the utmost importance when carefully done, and of great aid, and in a fair proportion of cases give information sufficient to give a correct diagnosis.

There is need of further investigation to improve on present methods of diagnosis, so that we may be able to make diagnosis certain in all cases in the minimum amount of time consistent with immediate treatment in the proper direction.

BIBLIOGRAPHY

1. Nichols, E. H.: Trans. Am. Orthop. Assoc., XI, 353–411, 1898.
2. Allison, Nathaniel: Arch. Surg., II, 593–626, May 1921.
3. Phemister, D. B.: Ann. Surg., LXXX, 481–500, Oct. 1924.
4. Brown, Lawrason: Osler's Modern Medicine, Philadelphia, Lea & Febiger, I, 428, 1925.
5. Zinsser, Hans: Infection and Resistance. Ed. 3, New York, MacMillan Co., p. 497, 1923.
6. Nichols, E. H. and Richardson, F. L.: J. Med. Research, XXI, 149–221, Sept., 1909.

News Notes

Two new members of the **Advisory Editorial Staff** have recently been appointed, Dr. H. Earle Conwell of Fairfield, Alabama, and Dr. Frederick A. Jostes of St. Louis, Missouri.

Dr. Packard Thurber has recently moved his office to 901 Subway Terminal Building, 417 South Hill Street, Los Angeles, California.

Dr. Emil S. Geist of Minneapolis has recently opened a new office in the Yeates Building, at 823 Nicollet Avenue.

Dr. Philip Lewin has moved his office from 7 West Madison Street to 104 South Michigan Avenue, Chicago.

Dr. Frederick A. Jostes, who has recently returned after a year and a half in Europe, has opened his office in the University Club Building, Grand and Washington Boulevards, St. Louis.

The office and laboratory of Dr. Reginald Burbank and Dr. L. G. Hadjopoulos has recently been moved from 52 West 53rd Street to 6 East 78th Street, New York City.

A message from Dr. Philip Lewin of Chicago states that he has recently received a communication from Dr. N. D. Royle of Australia indicating that he will be in Chicago some time during April, 1927.

Readers of the *Journal* will be interested to know that Dr. Elias Margo is now associated with Dr. Earl D. McBride in the McBride Reconstruction Hospital, in Oklahoma City. Dr. Margo is in charge of the general physiotherapy, x-ray work, and medical gymnastics.

Dr. Harry J. Fortin of Fargo, North Dakota, has returned to the Department of Bone and Joint Surgery in the Fargo Clinic and St. Luke's Hospital after a year's intensive study and training in the Orthopaedic Department of the Mayo Clinic under Dr. Henderson and Dr. Meyerding. Dr. Fortin will be associated with Dr. C. M. Callander in the section of Orthopaedic Surgery.

Conferences of the staff of the **Hospital for the Ruptured and Crippled,** New York City, are held at 3.30 P.M. on the fourth Thursday of each month beginning with September and continuing through April.

Meetings of the **Orthopaedic Section of the New York Academy** of Medicine occur at 8.30 P.M. on the third Friday of each month from October through May.

The Shriners' Hospital for Crippled Children, Philadelphia Unit, Roosevelt Boulevard, Philadelphia, Pennsylvania, was formally opened for admission of patients on July 24. Dr. DeForest P. Willard is Surgeon-in-chief, and Dr. Howard Moore and Dr. James E. Wyant assistants on the Orthopaedic Service. The capacity of the hospital is one hundred beds.

The Children's Orthopaedic Hospital of Seattle is planning to erect a new wing to the hospital, to be finished within the next year, whereby the capacity of the hospital will be increased to approximately one hundred and fifty beds.

Dr. Willis C. Campbell of Memphis, Tenn., was a guest at the meeting of the **Oklahoma State Medical Association** and Orthopaedic Surgeons of Oklahoma City on June 23, and demonstrated his technique on arthroplasties.

Oklahoma organized a State Society for Crippled Children on September 24, 1925, and according to a paper by Dr. Earl D. McBride of Oklahoma City at **The Oklahoma State Medical Meeting,** many clinics for crippled children have been held throughout the state and about 1000 children have been examined.

The Chicago Orthopaedic Club will hold its next meeting on October 9. Dr. Ralph Pemberton of Philadelphia will be the guest of honor. He will speak on the subject of "Some Aspects of the Arthritis Problem." Dr. Philip Lewin is now secretary of the club.

The Clinical Orthopaedic Society, formerly called the Central States Orthopaedic Club, will meet in Detroit and Ann Arbor, Michigan, on November 5 and 6, 1926. At the first day's meeting in Detroit, Dr. A. D. LaFerte, Dr. R. V. Funston, Dr. F. G. Curtis, Dr. C. W. Peabody, and Dr. F. C. Kidner will give a clinical program for the visitors at the Detroit Receiving Hospital, Harper Hospital, The Children's Hospital of Michigan, The Children's Convalescence Home at Farmington, and at The Henry Ford Hospital. The following day in Ann Arbor, the program for a clinical day will be in charge of Dr. Carl E. Badgeley, head of the Orthopaedic Service at the University of Michigan. Dr. Henry Meyerding, of Rochester, Minnesota, is secretary of the Society.

The Fourth Annual Meeting of the **Great Northern Railway Surgeons' Association** was held in Winnipeg, on June 25 and 26, 1926. About 230 of the surgeons of this great railway corporation were present. The President, Vice-President, and General Claims Agent attended, indicating the interest taken by the executive heads of the company in the work of their railway surgeons. The program included papers on general medical and surgical topics considered from the industrial standpoint. Two local orthopaedic surgeons took part in the program. Dr. H. P. H. Galloway, Associate Professor of Clinical Surgery (in charge of the Orthopaedic Surgery), University of Manitoba, spoke on "Excision of the Knee and Disarticulation of the Hip"; and Dr. W. A. Gardner, lecturer in Orthopaedic Surgery in the same university, read a paper on "Interpretation of Lumbar Pain".

The Pacific Northwest Orthopaedic Society completed its first year with a Clinical Meeting and Banquet in Spokane, Washington, July 1. The officers responsible for the organization and activities of the first year were Dr. Edward A. Rich of Tacoma, President, Dr. Chas. R. McClure of Portland, Oregon, Vice-President, and Dr. Roger Anderson of Seattle, Secretary.

The annual meeting in Spokane was held in the Shriners' Unit of St. Luke's Hospital. The guest of honor was Dr. Arthur Steindler of Iowa City. Dr. Mitchell Langworthy arranged the clinic and provided for observation and discussion a group of cases of extreme deformities due to poliomyelitis and scoliosis. Dr. Steindler reviewed the cases, their past treatment, and suggested practical measures to secure function in a few selected cases. Little by way of radical surgery was suggested in many of the more severe cases. Dr. Steindler took time to outline the technique and prognosis of several of his own operations in the thumb, elbow and heel. After the evening's banquet Dr. Steindler gave an illustrated lecture on his newer work with scoliosis.

The following members were elected officers for the coming year: Dr. Otis Akin of Portland, President, and Dr. Chas. R. McClure of Portland, Secretary. The next meeting will be held in Portland.

On June 10 and 11 there occurred in Chicago the dedication of the **John B. Murphy Memorial.** This beautiful building has been erected through the efforts of the friends of the late Dr. John B. Murphy. The John B. Murphy Association, the organized body under whose direction the funds were raised and the building erected, through its president Mr. Leroy A. Goddard, formally presented the building to the American College of Surgeons for its uses. Dr. Rudolph Matas, the president of the American College of Surgeons, accepted it on behalf of the College. Following his acceptance there were addresses by: Dr. William Mayo, Dr. Franklin H. Martin, Dr. George W. Crile, Dr. W. W. Chipman, Dr. George D. Stewart.

The building contains a lecture hall, seating about 250, and an auditorium accommodating about 1,000. These halls will be open to gatherings of medical and other scientific societies. Additional rooms will be available for clinical and literary research work. Dr. Mayo in his address characterized the building as "The Atheneum of Surgery".

The following quotation was pronounced by President John A. Cousens at Tufts College Commencement on June 14, 1926, at which time the degree of Doctor of Science was conferred upon Dr. John Ridlon of Chicago:

Dr. Ridlon, member of the Class of '76, you left this campus in 1874, your undergraduate course unfinished. Twenty-five years later, in 1899, you returned to receive at the hands of a grateful college the honorary degree of Master of Arts. Once more you have come back, celebrating with your classmates the fiftieth anniversary of Commencement. Alma Mater is proud to number you among her distinguished sons. For almost half a century you have been true to the best traditions of the noble profession of medicine. In the city of your adoption you have made a reputation second to none as an orthopaedic surgeon.

John Ridlon—Doctor of Science.

At the Commencement of Trinity College on June 14, 1926, the honorary degree of Doctor of Science was presented to Dr. Ansel G. Cook of Hartford, Connecticut, with the following address:—

Hunc virum, praeses reverende, Collegii Medicorum et Chirurgorum alumnum, peritum chirurgum corporis, animi medicum benignum, avium vocum non ignarum, qui postquam patria nostra bellum suscepit, statim ad castua se contulit, ubi multos artem suam docebat; qui autem instrumenta permulta ad ossa et membra dolentia levanda invenit, quorum ratiorem aliis libenter donavit, ad te duco Anselmum Granville Cook.

Auctoritate huius Academiae mihi commissa et honoris causa admitto te ad gradum Doctoris Scientiae tibique omnia jura, privilegia, et dignitates quae aut hic aut alibi ad istum gradum spectant, do et concedo. Cuius rei hoc tibi diploma sit testimonio.

The Minnesota Orthopaedic Club met in Rochester for its midsummer clinical meeting on July 31. This organization includes in its membership all surgeons doing exclusively bone and joint surgery in the State of Minnesota.

After witnessing an arthroplasty on the knee by Dr. H. W. Meyerding at the Colonial Hospital, the club was shown a dry clinic in the new quarters of the Orthopaedic Section of the Mayo Clinic.

A series of cases, recently operated upon, and end results in arthroplasty of the knee joint were shown by Dr. Melvin Henderson, also cases showing end results after employment of the Campbell bone block arthrodesis of the ankle for relief of foot drop due to poliomyelitis, and several cases of arthrodesis of shoulder in tuberculosis of that

joint. Dr. H. T. Jones exhibited several cases, both recent and end results, illustrating the possibilities in the employment of full thickness skin grafts in contractures found in the hands and various other parts of the body.

The next meeting of the club will be held in Duluth on October 18. Dr. H. Winnett Orr of Lincoln, Neb., will be the guest of honor.

At a meeting on June 15 the following were elected associate members of the **British Orthopaedic Association:**

R. Watson Jones, F.R.C.S., Royal Infirmary, Liverpool.
M. C. Wilkinson, M.R.C.S., L.R.C.P., Heritage Craft Schools, Chailey, Sussex.
T. E. Stoker, M.B., Wingfield Orthopaedic Hospital, Headington, Oxford.

The following associate members were elected to full membership:

W. M. Oakden, F.R.C.S., St. Luke's Hospital, Lowestoft.
W. Briggs, M.B., 63 Preston New Road, Blackburn.
F. Crooks, 24 Regent Street, Nottingham.
W. Mercer, 3 Rothesay Place, Edinburgh.
C. Lee Pattison, King Edward VII's Hospital, Sheffield.

The following were elected honorary members of the British Orthopaedic Association:

Prof. J. S. B. Stopford, M.B.E., 7 Oxford Place, Victoria Park, Manchester.
R. B. Osgood, 372 Marlborough Street, Boston, Mass., U. S. A.
Royal Whitman, 71 Park Avenue, New York, U. S. A.
V. Putti, Istituto Rizzoli, Bologna, Italy.
J. E. Goldthwait, 372 Marlborough Street, Boston, Mass., U. S. A.
E. G. Brackett, 166 Newbury Street, Boston, Mass., U. S. A.
Murk Jansen, Oegstgeesterlaan 3, Leyden, Holland.

The following were elected corresponding members of the British Orthopaedic Association.

Albert Mouchet, 142 rue de Courcelles, Paris.
Prof. Henning Waldenstrom, Kommandorsgatan 3, Stockholm, Sweden.
Nathaniel Allison, 234 Marlborough Street, Boston, Mass.
Clarence L. Starr, Department of Surgery, University of Toronto, Toronto, Canada.
W. E. Gallie, 143 College St., Toronto, Canada.

EXTRA-MURAL POST-GRADUATE INSTRUCTION IN CANADA

Life Insurance Companies have long recognized the advantages to them of a well trained medical personnel in the territories which they serve. They gratefully acknowledge the part which the medical profession has played in the prolongation of life, during recent years, resulting as it has in increased income from premiums, and deferred death claims. Recently the Sun Life of Canada have expressed their appreciation in a very practical way, in that they have donated a substantial sum of money to be spent in improving post-graduate facilities throughout the Dominion of Canada. The administration of the fund has been relegated to a committee appointed by the Canadian Medical Association, on which the Sun Life is represented; and they have been working in conjunction with the various provincial and local executives. It was the intention of the donors that opportunities for post-graduate study should be brought right to the door of practicing physicians, especially those removed from university centres, who were not able to get away as often as they wished to the larger clinics. The committee concluded that this could best be done by sending prominent clinicians from all over the Dominion to the meetings of the various district societies. They also arranged for a Canadian Medical Night in each of the larger centres of Canada, to which speakers were brought from a distance.

Clinicians have been chosen from all of the specialties, the aim of the committee being to select those who would present subjects of interest to the general practitioner in such a way that they could be used in his everyday work. Of special interest to the readers of this *Journal* is the part played by orthopaedic surgeons. During the month of June, Dr. J. A. Nutter of Montreal was one of a group to make a tour of the district societies of the Province of Manitoba, speaking upon "Backache"; and in April the Canadian Medical Nights at Calgary, Edmonton, Vancouver, and Victoria were addressed by Dr. H. P. H. Galloway, of Winnipeg, on "The Details in the Treatment of Some Commoner Fractures."

The whole enterprise, which is now known as the Extra-Mural Post-Graduate Scheme of the Canadian Medical Association, is working out well. New life has been infused into the local societies in rural districts, while in the cities the Canadian Medical Nights have done much to inspire and enthuse the profession generally.

The Western Orthopaedic Association, at a meeting held in Los Angeles, May 29, 1926, adopted the following resolutions:—

WHEREAS: Doctor EDWARD HICKLING BRADFORD by his professional attainments advanced the cause of Orthopaedic Surgery in America from the time of its infancy to the present moment, when it is universally recognized as a distinct and important branch of the healing art,

and,

WHEREAS: Both by precept and by example he did always inspire younger men to original thought and to diligent effort along the lines of orthopaedic endeavor;

and,

WHEREAS: Through his tireless industry, civic far-sightedness, and broad humanity, great institutions came into being, whereby hopeless cripples were reclaimed and brought from a state of misery to one of self-helpfulness and of physical well-being;

and,

WHEREAS: In all departments of citizenship he set an example inspiring to all men;

and,

WHEREAS: Grievous bodily injury left his spirit calm, gentle and unchanged, so that no one ever heard him utter, nor ever heard anyone else quote him as having uttered, an uncharitable thought of any man;

and,

WHEREAS: So exalted was his spiritual ascendency that approaching blindness, instead of depressing him, did but elicit from him the sublime expression: "I realized that all this was but incidental and superficial compared with the resources of life, which can be nothing more than a temporary aspect of that spiritual experience in which I might prepare myself for larger service".

RESOLVED: That we, The Fellows of the Western Orthopaedic Association of America, do recognize and gladly, with all due deference, bear witness to our own incalculable debt to this great man;

RESOLVED: That the example of his life as an orthopaedic surgeon, as a great administrator, as a distinguished citizen, inspires us to further service in our individual fields of endeavor;

RESOLVED: That the example of his heroism in the shadow of appalling personal tragedy does, and forever shall, strengthen us to meet more manfully whatever adversity may be our lot.

RESOLVED: That two copies of these resolutions be properly engrossed and that one copy go to The Children's Hospital at Boston, where he labored, so that all men may see henceforth and for all time the veneration in which those who knew him best did hold him.

RESOLVED: That the second copy of these resolutions be kept in the archives

of this Association, so that those who come after us, and who might otherwise think over well of our efforts, may know directly from us the source of our inspiration.

RESOLVED, finally: That in the recognition and recording of these facts, we do not honor the memory of Doctor Bradford, but rather do ourselves honor; for in the presence of his undaunted soul ours stand now, and forever shall stand, uncovered.

(Signed) The Western Orthopaedic Association
by the Resolutions Committee:
S. F. Stewart, M.D.
James T. Watkins, M.D.

BRITISH MEDICAL ASSOCIATION

SECTION OF ORTHOPAEDICS

At the Annual Meeting of this Section of the Association held at Nottingham in July, 1926, Mr. H. A. T. Fairbank opened the discussion on *Non-Tuberculous Coxitis in the Young*. He said that this condition was due either to trauma or to infection. In simple synovitis of the hip-joint following trauma, recovery generally followed rest without immobilization. The importance of early recognition of juxta-epiphyseal strain in cases of adolescent coxa vara was emphasized. The protean manifestations of acute infective arthritis were presented and the desirability of free drainage strongly urged. Mr. Fairbank was of opinion that doubtful cases of pseudo-coxalgia should be treated as tuberculous affections of the joint until the diagnosis was established. It was suggested that late pain in untreated cases of congenital dislocation of the hips was due to arthritis rather than to static conditions. In osteo-arthritis juvenilis it was suggested that there was some predisposing factor of a congenital nature present, such as imperfect formation of the acetabulum or congenital subluxation; or on the other hand some traumatic factors producing coxa vara, malunited or ununited fracture of the femoral neck.

Mr. S. W. Daw drew attention to the difficulties associated with the early diagnosis of rheumatoid arthritis and to the problem presented by the differential diagnosis of early tuberculous affection of the joint and pseudo-coxalgia.

Mr. S. T. Irwin demonstrated by preparations the presence of a transverse cartilaginous bar between the articular cartilage of the head and the neck of the femur in children up to eleven years. He suggested that this bar prevented the separation of the epiphysis which was rarely found before that age.

Mr. T. P. McMurray suggested a simple classification of coxitis into tuberculous and non-tuberculous, the latter group being divided into traumatic and infectious subdivisions.

Mr. Harry Platt emphasized the importance of the age of the patient in the diagnosis of hip-joint infections and urged the importance of early recognition and treatment of a focus of extra-articular tubercle in the neck of the femur.

Mr. Alan Todd said that juxta-epiphyseal strain was a definite stage in the etiology of coxa-vara, and drew attention to the necessity for early diagnosis of congenital dislocations of the hip.

Mr. F. C. Pybus suggested that early operation for the eradication of a tuberculous focus in the neck of the femur was imperative before the joint became involved.

Mr. W. A. Cochrane was of the opinion that the angle of the plane of the epiphyseal line predisposed to slipping of the epiphysis of the head.

SECTIONS OF DISEASES OF CHILDREN AND ORTHOPAEDICS

Spastic Paralysis.

A joint meeting of these Sections of the Association was held on July 22, 1926, for the discussion of this subject. The discussion was opened by Dr. W. J. Adie, who after defining the scope of the subject, said that nothing had been added to the accurate clinical description of the condition given by W. J. Little eighty years ago. He discarded the view that the condition was a primary neuronic degeneration, and suggested

that birth injury (as distinct from meningeal hemorrhage) was a probable etiological factor of importance causing atrophic sclerosis. Sympathectomy for muscle spasm was not likely to influence spasticity as experimentally the operation had no effect on decerebrate rigidity in animals.

Mr. Blundell Bankart said that the condition was an upper motor neurone lesion. He advocated operative treatment of the condition and suggested that Stöffel's operation was the best method of treatment. Foerster's operation of posterior rhizotomy had been abandoned and the operation of sympathetic ramisectomy of Hunter and Royle had not given the results claimed for it. Beneficial results might also be obtained by the lengthening or shortening of opposing muscles.

Dr. John Beattie showed a series of motion pictures demonstrating the effect of ablation of the sympathetic nerve supply in goats and domestic fowls.

Mr. S. W. Daw was of opinion that generally operations on nerves are preferable to those on tendons.

Mr. Tyrrell Gray advocated extra-peritoneal operation on obturator nerves.

Dr. F. M. R. Walshe was of opinion that there was no histological or physiological evidence to support the operation of Hunter and Royle.

Dr. E. W. Neill Hobhouse was of opinion that spasm could be prevented in the early stages and the necessity for operation obviated.

Mr. Rocyn-Jones said that in addition to Stöffel's operation he always excised the tendon of the adductor longus in adductor spasm.

Dr. H. J. Capon advised early treatment, when the child is one or two days old before the diplegia has developed. He advocated the employment of lumbar puncture to relieve oedema and hemorrhage.

CLINICAL CONFERENCE AT THE HOSPITAL FOR RUPTURED AND CRIPPLED, NEW YORK CITY

CONFERENCE OF APRIL, 1926

Dr. Patterson—Case of Ruptured Triceps Tendon.

Dr. Patterson presented a case of ruptured triceps tendon.

On December 31, 1925, a fifteen-year old girl tripped on a piece of cord and fell on her elbow. Examination immediately after accident showed the right elbow to be markedly swollen. There was marked tenderness on the posterior of the elbow. There was considerable ecchymosis. There was an area of softness above the olecranon process rather than the ordinary tension of the triceps tendon. The power of extension of the forearm was greatly diminished. The patient was admitted to the Hospital for Ruptured and Crippled where x-ray examination of the elbow showed a very small bit of cortex of bone lying some three inches above the olecranon process. It was assumed that this had been carried along with a ruptured triceps tendon.

At time of operation a five-inch vertical incision was made on the posterior of the elbow joint. There was a hematoma in the soft parts. The triceps tendon had been pulled loose from its fascial attachment, one inch below the olecranon process. The main body of the fibres had retracted up the back of the arm some three inches. Some thin fibres where the ligaments expand laterally were still intact. The tendon was pulled down and sutured to the olecranon process with kangaroo tendon, two such sutures being run through drill holes in the olecranon. The wound was then closed in layers with catgut and the arm then put up in plaster in extension.

The arm was kept in plaster a little over two weeks. This was then removed and physiotheraphy instituted. Patient after several months of physiotheraphy would never flex the arm past a right angle. It was believed that this bordered on an hysterical element. She was, therefore, referred to a psychiatrist who with two treatments of mental suggestion convinced her that the elbow was normal. She now has a normal range of motion and normal function of the elbow.

DR. WHITMAN—Illustrative Cases of Fracture of Neck of Femur.

Dr. Whitman presented two patients under treatment for fracture of the neck of the femur.

The first, a physician, 68 years of age, was seen several days after the injury. Meanwhile he had what was called the abduction treatment applied at another hospital which was ineffective in relieving pain for manifest reasons.

The fracture was of the small part of the neck and the x-ray picture showed, following the application of the abduction spica, perfect apposition. The discomfort was immediately relieved and the patient now spends the day on the hospital roof.

The second case was in a man 36 years of age, and illustrated a so-called walking fracture as the patient was able to walk with the aid of a cane though with much pain. This was an incomplete fracture, the neck having been displaced somewhat backward and downward. The abduction treatment was applied in the usual manner.

Dr. Whitman said that the interne of the present day accustomed to the routine of the abduction method did not realize the condition before its introduction and he therefore read from a representative text book the directions for treatment of this injury to show their vague and indefinite character.

DR. ROBERTS—A Case of Chondromatosis of the Elbow.

Dr. Roberts presented a case of chondromatosis of the elbow which he states is important because the condition is relatively infrequent in this joint. For two years the man has complained of occasional stiffness of the elbow and recently has been handicapped by limitation of extension at about 150 degrees.

An x-ray showed numerous shadows of loose bodies and the patient was admitted for removal of these. At operation fifteen osteocartilaginous masses, varying in size from a pea to a marble were found within the capsule, some entirely free and others pedunculated. After removal of these the full range of joint motion was reestablished. The patient was discharged with a practically normal elbow.

DR. BURDICK—Fracture of the Femur in a Child; Spontaneous Correction of Deformity.

Dr. Burdick presented a boy eleven years old, who was admitted to the Bellevue Hospital on September 25, 1923, with a transverse fracture of the middle of the shaft of the right femur, only slight overriding. Fragments were reduced under the fluoroscope with ether anaesthesia and a plaster cast was applied.

Subsequent x-rays showed that the fragments had slipped and there was marked overriding. Several attempts were made to correct the deformity and although the overriding was corrected there was still marked forward and inward displacement of the upper fragment. The last attempt to correct the deformity was made five weeks after admission and at this time there was slight fibrous union and upon discovering this no further attempts at reduction were made, but the plaster cast was reapplied. Two months after admission the cast was removed, there was firm union and both extremities measured the same.

The x-ray ten weeks after the injury showed an enormous amount of callus with still marked antero internal displacement of the upper fragment. Eighteen months after injury the x-ray still revealed the presence of considerable callus but the deformity was very much less. Two and one-half years later the x-ray revealed a practically normal shaft with no evidence of callus formation and the entire disappearance of the bony deformity. The affected limb shows one-half to one cm. lengthening. The patient walks with no limp and all motions are normal.

This case illustrates what almost invariably happens in fractures of the femur in children. An enormous amount of bony deformity with a large formation of callus is practically sure to disappear within a period of one to three years and an appreciable lengthening of the fractured limb is not at all uncommon.

In a series of 500 cases of fracture of the femur, we have found it to occur in between five and ten per cent. of the cases. Needless to say open operation in these cases is definitely contraindicated.

DR. KLEINBERG—Epiphyseal Fracture of the Hip.

Dr. Kleinberg presented a boy fifteen years old, who had sustained an epiphyseal fracture of the right hip, to demonstrate that the deformity in this lesion may be corrected and the fracture healed by appropriate treatment, even if this be delayed for a long time.

The boy was of the overgrown fat type. He had suffered an epiphyseal fracture of the right hip about a year previously through a fall from a bicycle. He was treated in his home town by an application of a plaster-of-Paris spica bandage. This was removed after seven weeks and the patient encouraged to walk. The progress was not satisfactory. A limp, pain in the hip and increasing disability compelled the patient to seek additional advice and relief.

On admission the examination showed a typical epiphyseal fracture. The limb was in outward rotation and somewhat shortened. The motions at the hip were restricted and painful. Abduction was practically entirely checked. An x-ray picture showed a coxa vara with downward displacement of the femoral head.

Under an anaesthetic the limb was manipulated. By strong force and hard stretching continued for about ten minutes the limb was brought into complete extension, inward rotation and abduction of about seventy degrees. A subsequent x-ray examination showed that the deformity was entirely corrected and that the head and neck were in normal alignment.

The point of special importance was the possibility of correcting a marked deformity resulting from epiphyseal fracture of the hip many months after the injury without an open operation.

CORRECTION: Dr. Maxwell Harbin of Cleveland, Ohio, recently has called the attention of the Editor to an error in his article on Non-suppurative Osteomyelitis, which appeared in the *Journal* of April, 1926. The legends for Fig. II on page 402 and Fig. III on page 403 should have been interchanged.

Current Literature

INJURIES OF THE WRIST. A RADIOLOGICAL STUDY. By the late Dr. Etrénne Destot, Lyons. Translated by F. R. B. Atkinson, M.D., C.M., Edinborough University. New York: Paul B. Hoeber, Inc., 1926.

It is unusual to find a book presenting its subject with such completeness as does this work of Dr. Destot. It represents the study of the subject by the author over a period of more than twenty years, and deals almost entirely with his own experiences and his personal observation of cases among his confrères which he had had occasion to see and opportunity to study. The book largely deals with the injuries to the carpus, but includes a valuable chapter on the Colles' fracture, the varieties of which are presented in a clear classification.

The first chapter deals with the anatomical and physiological features of the wrist and forearm, and especially in reference to their influence on the mechanical forces which produce the fractures and dislocations common to this region. This discussion is a definite aid to the better understanding of the various types of these injuries, and also helps in the explanation of the principles to be used in their reduction. The chapter also gives useful information, using the normal as a basis, in reference to the clinical examination and to the interpretation of the x-rays, and emphasizes the study of the exact relation of the carpal bones.

The succeeding chapters take up the various injuries, treating, in order:

Sprains and subluxations of the scaphoid and of the semilunar,

Fractures of the scaphoid,

Dislocation of the carpus, and mid-carpal luxation,

Fractures of the semilunar,

Rare fractures of the other bones,

Radio-carpal luxation,

The different forms of fracture of the lower extremity of the radius.

These varieties of injuries are considered in detail, and diagrams as a supplement to the interpretation of the x-rays are added to the many illustrations. The reproduction of the x-rays deserves mention, as well as the care with which the views are taken, for seldom is seen such clearness of detail. One may frequently wish that the legends were more complete and gave more detailed explanation, for it is occasionally difficult to grasp what long study has made clear in the author's mind. The question of operation is carefully, but not extensively, discussed, as well as the technique of some of the operative procedures, but the reader is left with a feeling of finality which has resulted from definite opinions based on sound judgment.

The book is so thorough in its detail that it must be used as a reference and as an opportunity for study of the various injuries, whenever special information is desired. In general, it deals more with the features of anatomy, pathology and mechanics which lead to a clear understanding of the individual injuries than with the therapeutic features. It is a valuable book for all who are engaged in the treatment of these injuries.

CONTRIBUTION TO THE STUDY OF THE PARALYSIS IN POTT'S DISEASE. Madame le docteur Sorrell-Dejerine. Thesis 1926. Paris. Masson et Cie.

The wife of Dr. Sorrell (Berck sur le Mer), in her study of forty patients afflicted with vertebral caries complicated with paraplegia, finds that this paralysis could be arranged in three groups:

1. Transitory form, due to the oedema in the cord, at the level of the tubercular focus; this paraplegia disappears in a few weeks.

2. Curable form, which can be treated in a period of eighteen months to two years. In these cases the paraplegia comes suddenly and in a very short time is complete. Its more frequent cause is the presence of an intraepidural abscess. Under a proper immobilization this paralysis is cured in ninety per cent. of the cases.

3. Chronic form; in these cases the paraplegia makes its appearance rather late and its evolution can last years. Pachymeningitis lesions, bone sequestra or vascular alterations are its more common causes. This kind of paralysis is never cured and always affects the patients not treated by proper immobilization.—*Felipe Muro, M.D., Detroit, Mich.*

THE PROPER CLASSIFICATION OF CEREBRAL PALSIES OF EARLY LIFE. B. Sachs. *Am. Jour. Med. Sc.*, CLXXI, 376, 1926.

It is emphasized that the group of cerebral palsies generally included under the term "Little's Disease" are due to a large variety of causes. The author states that in attempting to classify and interpret these palsies the exact form of the paralysis is unimportant, but that it is important to determine whether the morbid process had its beginning before birth, at birth, or in extra-uterine life. The author's classification is as follows:

Groups	*Clinical forms in order of frequency*	*Morbid lesion*
I. Paralyses of intrauterine onset	Diplegia, paraplegia, hemiplegia	Large cerebral defects (porencephaly); defective development of pyramidal tracts; agenesis corticalis (highest nerve elements involved); polioencephalitis (?); primary neuronal degeneration.
II. Birth palsies	Diplegia, paraplegia, hemiplegia, diataxia, cerebellar form.	Meningeal hemorrhage, rarely intracerebral hemorrhage. Later conditions: meningo-encephalitis chronica; lobar sclerosis and cysts; partial atrophies.
III. Acute (acquired) palsies	Hemiplegia, paraplegia, diplegia, choreic and athetoid disorders (unilateral and bilateral).	Hemorrhage (meningeal and rarely intracerebral); thrombosis (from syphilitic endarteritis and in marantic conditions); embolism. Later conditions: atrophy; cysts and sclerosis (diffuse and lobar); meningitis chronica; acute encephalitis (cortical and striatal); polioencephalitis acute (Strümpell).

—*J. A. Key, M.D., St. Louis, Mo.*

RAYNAUD'S DISEASE. J. J. Monahan. *Am. Jour. Med. Sc.*, CLXXI, 346, 1926.

The author uses the term "Raynaud's Disease" to include all gangrenes, moist or dry, symmetrical or asymmetrical, deep or superficial, which give evidence of being due to defective vasomotor influence. The wide variation in the clinical pictures of the cases in the literature is discussed, and the presence of a chemicophysiological toxin is suggested as the cause of the condition.

A case is reported which is unusual in that a considerable portion of the bones of the forefoot were sloughed out in a discharge which was found to be sterile, and because the foot showed changes in form corresponding to the altered function of the uninvolved outer portion.—*J. A. Key, M.D., St. Louis, Mo.*

THE CALCIUM CONTENT OF THE BLOOD IN GOUT AND ARTHRITIS. Philip Horowitz. *Am. Jour. Med. Sc.*, CLXXI, 560, 1926.

The blood sugar, urea nitrogen, uric acid, creatinin and calcium in seventy-eight cases of arthritis are given. Unfortunately the type and degree of arthritis present in each case are not noted. In five of fourteen cases of arthritis deformans the blood calcium was above normal. In most of the seventy-eight cases the calcium was within normal limits, but in one case complicated by otosclerosis, and in others complicated by chronic nephritis, hypocalcemia was present.

The uric acid was high in sixty-two of the seventy-eight cases.

The blood calcium was high in acute gout and normal in chronic gout.— *J. A. Key, M.D., St. Louis, Mo.*

EPIPHYSITIS. Editorial, *Am. Jour. Roentgenol.*, XV, 446, May 1926.

This editorial is mentioned here, not because it contains any new additions to our knowledge of the subject of epiphysitis, but because it calls attention to the valuable abstracts that are appearing in subsequent numbers of the Am. Jour. Roentgenol. of recent articles, collected from all sources, regarding this condition. According to the Editor, epiphysitis is a true disease entity, of unknown origin, but distinct from tuberculosis, syphilis and rachitis. Among the diseases classified under the head of epiphysitis, or osteochondritis, he includes: (1) osteochondritis deformans juvenilis (Legg-Calvé-Perthes' disease), (2) epiphysitis of the tibial tubercle (Osgood-Schlatter's disease), (3) epiphysitis of the tarsal scaphoid (Köhler's disease), (4) epiphysitis of the head of the second metatarsal (also called Köhler's disease), (5) vertebral epiphysitis, (6) epiphysitis of the os calcis, (7) epiphysitis of the olecranon, (8) epiphysitis of the various epiphyses of the ilium, (9) malacia of the semilunar bone, (10) osteochondritis dissecans of König. —*Roades Fayerweather, M.D., Baltimore, Md.*

METASTATIC CARCINOMA IN BONE. Joseph H. Luscinian. *Am. Jour. Roentgenol.*, XV, 530, June 1926.

Two cases of metastatic carcinoma in spine and pelvis "so unusual in their (x-ray) appearance that it was considered of sufficient general interest to report them. No previous report of a similar case was found in the English literature." Both were metastases from breast tumors. The bone lesions show complete absence of bone destruction, only hyperplasia. "Pain in the bones or joints, of a rheumatic character, in patients suffering from any form of malignant disease should at once arouse suspicion of metastasis . . . the entire skeleton should be thoroughly investigated." The principal points in the differential diagnosis of this hyperplastic type of metastasis from the so-called "marble bones" disease and osteitis deformans are cited.—*Roades Fayerweather, M.D., Baltimore, Md.*

LYMPHOBLASTOMA (HODGKIN'S DISEASE) OF THE STERNUM. Richard Dresser. *Am. Jour. Roentgenol*, XV, 525, June, 1926.

Four cases of bone invasion, all of the sternum, have been observed in a total of ninety-five cases of Hodgkin's disease treated in the department of radiation therapy of the Massachusetts General Hospital during the past three years, and are here reported. In each instance the bone involvement represented a complication of a generalized process. It is said that the bone lesion may be the first evidence, occasionally, of the disease. A special technique of irradiation must be employed to avoid injury to the skin. The bone lesion responds readily to such treatment, and the latter may be carried out during a period of several years; however, it is only palliative.—*Roades Fayerweather, M.D., Baltimore, Md.*

RECONSTRUCTION OF HIP JOINT DISORGANIZED BY CHARCOT'S DISEASE. Jos. P. Hoguet. *Ann Surg.*, LXXXIII, 693, May 1926.

This is the report of a case in which the Whitman reconstruction operation was performed. An excellent result was obtained. Antisyphilitic treatment was continued and the disease has not progressed.—*F. G. Hodgson, M.D., Atlanta, Ga.*

UNUNITED FRACTURE OF THE HIP. M. S. Henderson. *Ann. Surg.*, LXXXIII, 696, May 1926.

This is a report of cases treated in the Mayo Clinic from 1919 to 1925, inclusive. Cases are carefully selected. Three types of operation were performed: (1) Autogenous bone graft, using the fibula as a peg to hold the freshened surfaces of the neck and head together. This was the method preferred when there was a good neck. (2) Brackett's operation was used when there was much absorption of the neck and the head seemed viable. (3) The Whitman reconstruction operation was used in the elderly and where there was any doubt as to the viability of the head. One hundred and seventy-five cases were examined. Twenty-one were fresh fractures. Thirty-one had painful hips, but no non-union. Ten had pathological fractures. This left 113, and of these only thirty-five were operated upon. Twelve others were advised to have an operation, but did not do so. Results of operation: bone graft, sixteen cured, five not cured, two unknown; beef bone peg, three cured; Brackett, two cured; Whitman, four cured.—*F. G. Hodgson, M.D., Atlanta, Ga.*

SOME BIOLOGIC EVIDENCE OBTAINED FROM A STUDY OF CONGENITAL DISLOCATION OF HIPS IN IDENTICAL TWINS, SUPPORTING THE DEVELOPMENTAL THEORY. Delley Hale. *Ann. Surg.*, LXXXIII, 682, May 1926.

One twin had a dislocation of the left hip associated with a right internal strabismus and sucked her right thumb. The other had a dislocation of the right hip associated with a left internal strabismus and sucked her left thumb. The toe prints revealed a symmetrical reversal or mirroring of the prints of the left great toe. All this he considers as pointing to a developmental theory of the cause of congenital dislocations. They were treated by the usual methods of closed reduction and plaster casts with good results.—*Fred G. Hodgson, M.D., Atlanta, Ga.*

ACUTE OSTEOMYELITIS IN CHILDREN. C. E. Farr. *Ann. Surg.*, LXXXIII, 686, May 1926.

He believes the skin is often the source of the infection. He does not consider trauma a causative factor. The location of the lesion was given in ninety-eight cases. There were six deaths. The treatment was along usual lines.—*F. G. Hodgson, M.D., Atlanta, Ga.*

ACUTE KNEE JOINT INJURIES. C. J. McGuire, Jr. *Ann. Surg.*, LXXXIII, 651, May 1926.

This is a report of cases occurring in Bellevue Hospital during the past five years. They are classified as follows:

(1) Synovial membrane—acute synovitis and suppurative synovitis. One suppurative case cleared up completely in eight days after three aspirations. Willem's treatment was tried in nine cases; five obtained full function, one partial function, one complete ankylosis, two amputations.

(2) Ligaments—with thirty degree flexion and sufficient period of immobilization the crucial ligaments will heal with good function. He does not consider the Hey-Groves operation justifiable. Suture of the internal lateral ligament, with fascial reënforcement if necessary, is successful. Suture of the quadriceps tendon and of the ligamentum patellae gave good results.

(3) Intra-articular fibrocartilage. Fifteen operated cases are reported. Eleven cases gave normal function, two did not report, but evidently were without disability when last seen, one developed postoperative phlebitis and developed an unstable joint, one complained of persistent pain.

(4) Fractured patella. These were all operated upon if there was any separation. Twenty-five cases reported. One developed suppurative arthritis. Seventeen were operated upon; of these, fifteen cases were followed up and reported complete function, one, seen only once, was doing well, one did not report.

(5) Intercondylar eminence—four cases. Treated in thirty degree flexion for six weeks. One perfect function. Three complained of recurrent synovitis and pain on standing.

This is a most interesting article and a table of all the cases showing treatment and end-results is given.—*F. G. Hodgson, M.D., Atlanta, Ga.*

CONCERNING THE ETIOLOGY OF PERTHES' DISEASE AND KOEHLER'S METATARSEPHALANGEAL DISEASE. W. Brill. *Arch. f. Orthopaed. und Unfallchir.* XXIV, 1, January 1926.

The author reports a family in which for six generations there occurred a disease in the hips among its members. It is a case of inherited constitutional anomaly. The primary symptoms in childhood are: stiffness in the hips, limitation of abduction and rotation with persistence of normal expansion and flexion. Pain is not complained of, as a rule. Around the fifteenth year there appeared the symptoms of limitation, limping, aching, which in previous years has been but of mild character and frequently overlooked. Up to the age of twenty-five, the condition gradually improves; it becomes stationary at the ages of forty-five or fifty. The x-rays demonstrate processes which seem to originate within the bone substance proper. These findings speak against an arthritis deformans juvenilis but lean more, radiologically and clinically, towards the group of Legg-Perthes'. Analogous processes as in the hips are found in the heads of the first and second metatarsals and on the femoral condyles. In several instances, the diseased processes occur bilaterally. In childhood many members of this family present symptoms of spasmophilic diathesis, later those of rickets and asthenic and hypoplastic constitution. It is difficult to point to a definite date of onset; neither can it be stated with certainty in what period the disease becomes aggravated. No lues, tuberculosis, nor a single trauma can be regarded etiologically; neither can local emboli nor osteomyelitis be mentioned as causative factors. Disturbance of internal secretion may easily be suggested and accepted as a probability. The final results of all the cases were arthritis deformans in later years.—*A. Gottlieb, M.D., Los Angeles, Calif.*

GROWTH DISTURBANCES FOLLOWING RESECTION OF JOINTS: S. L. Haas, M. D., San Francisco. *Arch. Surg.*, p. 56, July 1926.

In an effort to determine the effect of resection of joints on the growth of bones, Haas performed twelve experiments on young, growing rabbits. The articular cartilage, with a thin layer of bone, was removed from the tibia, fibula and patella. Only four animals lived a sufficient length of time to permit deductions.

Basing his conclusions on the results in these four experiments, he believes that a careful resection in which the epiphysis has not been hurt will cause practically no disturbance in growth.—*I. Wm. Nachlas, M. D., Baltimore, Md.*

SPONTANEOUS DISLOCATION OF THE TENDON OF THE LONG HEAD OF THE BICEPS BRACHII: A. W. Meyer, M. D., Palo Alto, Calif. *Arch. Surg.*, p. 109, July 1926.

After recording and "dissecting" the earlier reports of dislocation of the tendon of the long head of the biceps, the author mentions four instances of this condition that have come to his attention. These observations were made in the course of study of 286 cadavers, an incidence of 1.25 per cent. The frequency of these findings, post-mortem, would lead one to believe that it should be seen more frequently clinically. While there are no detailed descriptions or illustrations of the pathological changes in the dissected specimens, there is a discussion of the probable etiology. Meyer believes that the destruction of part of the articular capsule is a necessary antecedent to the dislocation which could then take place easily when the arm is fully abducted and externally rotated, particularly when the elbow is flexed and the forearm supinated.—*I. Wm. Nachlas, M. D., Baltimore, Md.*

THE CONTROL OF INTRACTABLE PAIN IN LUMBAR REGION, PELVIS AND LOWER EXTREMITIES: Max Minor Peet, Ann Arbor, Mich. *Arch. Surg.*, p. 153, August 1926.

As an addition to our armamentarium for the control of pain in the lumbar region, pelvis and lower extremities there is offered a relatively new procedure—chordotomy.

Peet reminds us that the pain associated with neoplasms in the spine has frequently failed to yield to even large doses of morphine. The section of the posterior roots, rhizotomy, has not proved satisfactory, first of all because in many cases the pain has persisted, and secondly, because a complete anaesthesia frequently follows the operation.

Chordotomy, that is, section of the anterolateral columns of the spinal cord, offers, in the author's opinion, a method for the control of intractable pain with relatively few complications. He reviews the cases reported in the literature and adds a study of nineteen patients on whom he performed this operation. Satisfactory relief was obtained in fourteen; in five, only partial relief was obtained.

Unlike the results obtained in rhizotomy, following this operation the author found no loss of tactile sensation, sense of motion and position or loss of motor function. The cutaneous and tendon reflexes should not be impaired.

The operation consists of exposure of the cord with section to a depth of three millimeters in front of the dentate ligament forward through the exit of the fibres of an anterior root.

While Peet feels that the operation offers no special difficulties to the neurologic surgeon he does not advocate it for the general surgeon.—*I. Wm. Nachlas, M. D., Baltimore, Md.*

Pinning the Fractured Ulnar Styloid Process in Colles' Fracture. Frank J. Hathaway. *Brit. Med. J.*, 59, July 10, 1926.

The author, while admitting the successful treatment of Colles' fracture depends upon the accurate reduction of the radial fracture, maintains that in many cases the cause of pain and weakness in the wrist is due to the permanent separation of the ulnar styloid process. The internal lateral ligament of the wrist is attached to the styloid process. The operation consists of an open approximation of the fragments and their maintenance by means of a straight bayonet-shaped needle driven through the fragment into the lower end of the ulnar in a direction downward and slightly towards the flexor or radial side of the forearm. The arm is placed in a Carr's splint for seven to ten days, after which it may be discarded, a firm bandage applied and massage and passive movements started.—*N. T. Williamson, M.D., Montreal.*

Late Decompression of Lumbar Cord Following Injury. W. O. Stevenson. *Can. Med. Assoc. Jour.*, XVI, 563, May 1926.

Male, 54, fell from ladder five years previously. Three months later returned to light work. Three years later he developed lumbar pain and had to use a cane to steady himself. A year after this, uncertainty in control of sphincters appeared; muscular weakness in lower limbs increased so that he was unable to walk steadily without the use of a cane.

On examination, asthenia, ataxia and atonia were shown in the lower limbs only. The lower limbs presented a few areas of disturbed sensation to touch, heat and cold. There was no wasting. Muscular tone was poor. The gait resembled that of a drunken man. The reflexes were normal, save for some depression of the knee jerks. The rectal sphincter was very active. X-ray showed a wedge-shaped first lumbar vertebra, with absence of the intervertebral disc between it and the second. The Wassermann reaction was negative.

Operation. The laminae of the twelfth thoracic, first and second lumbar vertebrae were removed. The dura perceptibly bulged when pressure was removed. It was not opened.

Six months later: the patient has regained complete sphincter control. He now walks quite steadily without a cane. The local pain has ceased and he is thinking of going to work.—*Alexander Gibson, F.R.C.S., Winnipeg.*

Syphilitic Periostitis of the Cervical Vertebrae and the Right Clavicle. L. C. Montgomery. *Can. Med. Assn. Jour.*, XVI, 563, May 1926.

Male, aged 61, complained of swelling left side of neck, pain radiating up to left ear, down over left shoulder; worse at night; duration four months.

On examination, pupils equally active. In left posterior cervical region was a flat raised area about 9 c.m. in diameter, extending downwards and backwards from the tip of the mastoid process. It was not nodular or tender; margins undefined; consistency rubbery; no enlarged cervical glands; no limitation of movement of head or neck.

Over inner third of right clavicle was an oval swelling the size of a peach stone. Its presence was unsuspected by patient. Remainder of physical examination essentially negative. Malignancy was suspected. Wassermann reaction three plus on two occasions. X-ray showed periostitis of left transverse process of third and fourth cervical vertebrae and of inner third of right clavicle.

Under antiluetic treatment the condition had entirely cleared up in two months.—*Alexander Gibson, F.R.C.S., Winnipeg.*

Compound Dislocation of the Lower End of the Ulna. Corrigan and Corrigan. *Can. Med. Assoc. Jour.*, XVI, 689, June 1926.

The patient was injured by a backfire while cranking his car. There occurred a long oblique fracture of the radius well above the extremity; 4 c.m. of the ulna protruded through the anterior aspect of the forearm, stripped clear of attachments and with the styloid process intact. The parts carried evidence of soiling with farmyard material. The force producing the injury was as follows: The engine having backfired, it continued to reverse, and the crank remaining connected, its hand-piece struck the arm on the posterior-radial aspect. The hand acting momentarily as a counter-weight, the radius was fractured and the ulna forced to an open dislocation.

Antitetanic serum was given and thorough cleaning done. The parts were easily restored to normal position. Carrel-Dakin irrigation was carried out and passive movements begun early. The patient regained a functionally correct arm, wrist and hand.—*Alexander Gibson, F.R.C.S., Winnipeg.*

Case of Hypernephroma with Bone Metastases. From Surgical and Pathological Dept. of Queen's University. Kingston. *Can. Med. Assoc. Jour.*, XVI, 691, June 1926.

Male, 68, tumor left side of neck posteriorly, accidentally discovered two weeks before. Complained of pain lower margin of ribs and back. This was September 1925. In September 1924, had been in hospital, diagnosis myalgia of back. Haematuria October 1924; cystotomy negative. Examination, September 1925, showed mass in left posterior triangle; no enlarged glands; swelling on ninth rib right side. X-ray showed enlargement of right kidney. Urine contained albumin and pus, but no blood October 1925. Temperature began to rise. Paraplegia developed. Extensive bedsore involved sloughing of part of sacrum. Death December 1925.

Autopsy. Left kidney 4 x 2½ inches, lower two-thirds of this organ replaced by tumor mass which had ruptured into the pelvis. No deposits in vertebral bodies. Upper thoracic spines infiltrated with growth pressing on cord. Metastases in mediastinal glands and ribs. Microscopically the growth was a hypernephroma.

This diagnosis is warranted partly by the position of the primary growth, partly by the character of the growth itself, notably the presence of lipoid material in large amount within the tumor cells. The origin of these tumors is still a moot point. It is not known with certainty whether they originate in the suprarenal or in the kidney itself.—*Alexander Gibson, F.R.C.S., Winnipeg.*

Bifurcate Ribs. An Unusual Cause of Deformity of the Chest. Bloomberg. *Can. Med. Assoc. Jour.*, XVI, 807, July 1926.

Boy, aged four, complained of a "lump on the chest", noticed two weeks before. On examination there was a round prominence about two and one-half inches in diameter at the level of the third rib, just to the right of the sternum. An x-ray showed bifurcation of third and fourth right ribs.

Anomalies are most common in the first and second ribs. Rarely are any below the third affected; the right side is more frequently affected than the left. Bifurcation

always occurs at the sternal end of the rib. The upper prong is usually, but not always, the longer of the two. In the present case, the crowding of the extra branches produced a mild "pigeon breast". The condition is obviously congenital.—*Alexander Gibson, F.R.C.S., Winnipeg.*

Cranial Metastasis of Hypernephroma. A. Harburger et J. Agostini, "Metastase cranio-meningee d'un hypernephrome latent". (*Soc. Anat. de Paris*, Jan. 7, 1926.) Abstract by D. M. G. in *Edin. Med. Jour.*, XXXIII, 515, August 1926.

Male, 69, tumor above right frontal eminence. Duration three months. Growth fairly rapid. Slight headaches. Tumor size of a nut, raised hairy scalp. Operation, local anaesthetic, tumor easily defined, red, firm, nodular. Adherent to bone. Tumor mushroomed through an opening in bone.

Histologically growth was hypernephroma.

Primary growth not revealed by physical or radiological examination.—*Alexander Gibson, F.R.C.S., Winnipeg.*

Radiographic Diagnosis of Tumors of Long Bones. Moulonguet and Lifschitz. *Jour. de chir.*, XXVII, 113, February 1926.

In malignant central bone tumors the authors stress particularly the irregularity in density and form of the growth, the periosteal reaction after the cortex is perforated, and the indefinite outline of the shadow.

In periosteal sarcoma the outline of the tumor is vague and irregular, the bone is eroded, and there is a periosteal reaction on the side of the bone opposite the tumor. Myelomas are multiple and show no periosteal reaction. Metastatic carcinoma show clear-cut areas of destruction and no periosteal reaction.

In benign tumors the shadows are sharply defined, the surrounding bone is normal, and the periosteum shows no reaction.

Enchondromas, bone cysts, osteomas, osteitis fibrosa, and giant-cell tumors are briefly described. The article is illustrated with twenty-five radiographs.—*J. A. Key, M.D., St. Louis, Mo.*

Technique of Extracapsular Resection of the Knee for Tuberculosis in Adults. P. Fredet. *Jour. de chir.*, XXVII, 241, March 1926.

The author uses an H-shaped incision, the horizontal bar of the incision crossing the knee just above the level of the tibial tubercle and the two vertical limbs being well posterior.

The skin and superficial fat having been separated from the fascia, the knee is flexed and the patellar tendon is cut across above and turned down. A transverse incision is then made at the level of the tibial tubercle and carried well back on each side. A similar incision is made above the patella and carried around to the posterior borders of the condyles and the ends joined to those of the lower transverse incision, thus isolating the patella and the lateral capsules. The quadriceps tendon is then split and the muscle turned back to expose the wall of the bursa. Beginning at the upper end, the bursa is dissected free from the bone and the entire mass, including the patella, lateral ligaments, semilunar cartilages, crucial ligaments, and posterior capsule, is removed in one piece. In performing the synovectomy all of the contours of the joint are carefully followed and every bit of the joint lining is included in the piece removed. The posterior surfaces of the femur and tibia are thus freed for a distance of an inch or more.

A broad H-shaped plate of metal is now placed behind the bones and in front of the popliteal vessels and the knee is straightened. With a short saw the femur is cut nearly through at the desired point and the saw is left in place to act as a guide for cutting the tibia. With a longer saw the tibia is now cut at the desired point and in a plane parallel with the short saw. The excision of the condyles of the femur is now completed. In sawing the bone the H-shaped metal plate not only protects the popliteal structures from injury but acts as an efficient retractor for the skin as its ends project on either side. The broad crossbar of the H lies transversely behind the bones. In cutting the bones the

author endeavors to remove all of the diseased tissue, but takes off no more bone than necessary.

The bones are now held together and drilled obliquely, and a figure-of-eight wire suture is passed and twisted to hold them firmly together. The patella tendon is sutured to the quadriceps muscle and the deep fascia is united on either side. The skin is then trimmed until it fits snugly and is sutured loosely without drainage and a plaster cast is applied. This is changed one month later when the sutures are removed and x-rays are taken. Firm bony union is to be expected in three months, but the patient is kept in bed one month longer and then begins to walk without apparatus.

The author has performed the operation twenty-seven times, on patients ranging in age from seventeen to sixty-one years. In twenty-five cases the disease was cured. In two advanced cases it was necessary to amputate the limb later. There was no operative mortality. The paper is illustrated by excellent drawings of the various steps in the operation.—*J. A. Key, M.D., St. Louis, Mo.*

Diagnosis in Orthopaedic Surgery. Frank R. Ober, M.D. (Boston). *Jour. Am. Med. Assoc.*, LXXXVI, 1813, June 12, 1926.

Most weaknesses in making a correct diagnosis of a patient may be attributed to (1) bad elementary training; (2) insufficient knowledge of the fundamental subjects in medicine; (3) lack of proper hospital training; (4) incomplete physical examination; (5) failure to make a thorough search for the cause of the ailment; (6) premature selection of a specialty; (7) dependence on roentgen ray alone.

As any good doctor, the good orthopaedic surgeon must be trained in early life to observe in an orderly manner and apply these faculties later in assembling the essential history, physical examination and laboratory findings, for a correct diagnosis.

There are four diseases which are often diagnosed late and which supply more cripples than all other orthopaedic conditions combined: acute osteomyelitis, acute poliomyelitis, bone and joint tuberculosis and chronic arthritis. Acute infections in bone should be recognized before the radiogram is positive and proper treatment instituted to prevent the chronic disability so commonly found.

The recognition of acute poliomyelitis is in the province of the orthopaedic surgeon and though he may not be actively treating the patient, his influence can be effective in the recognition of early cases.

Arthritis cases should receive careful study, not only of the local condition, but of the entire body function. Many will be relieved who would otherwise have their teeth extracted, tonsils removed, then "go the rounds", finally reaching the stage of chronic invalidism.

Bone and joint tuberculosis can be diagnosed early in a large percentage of cases, but there remains some twenty per cent. in which the diagnosis is strongly suspected, but cannot be proven. Rather than treat these expectantly for months, with consequent damage to joints, it is far better to make a biopsy, examining the sections and inject two guinea pigs with part of the macerated tissue. Positive cases, particularly in adults, will be saved prolonged disability and ultimately recover with a better result.—*W. B. Carrell, M.D., Dallas, Texas.*

Ankylosing Operations on the Tuberculous Spine. A Study of Fifty-three Cases. Leonard W. Ely (San Francisco). *Jour. Am. Med. Assoc.*, LXXXVI, 1748, 1926.

Ely collected fifty-three histories of patients who had been operated on for spinal caries 1914–1925, through the Orthopaedic Clinic of Stanford University and including his personal cases. Twenty-eight of these are classified as cures, meaning that the spine is ankylosed and that they are free from symptoms. The non-operative treatment as generally practised is irrational because it does not result in fixation of the spine. Granulation tissue extending into the joint is an attempt to stop motion but is rarely successful. Recurrence of symptoms in postoperative cases is frequently due to the imperfect

fusion of one segment or failure to include enough vertebrae. A second operation was done in fourteen cases, and in one a third, before recovery was complete. In none of the cases did abscesses develop or increase in size after the bony bridge had formed. Deformity increased in a few cases but in most of them, with suitable splinting, was checked. The technique of Hibbs generally preferred, but Albee's suitable for small localization and in lumbar caries. Postoperative recumbency six weeks, brace six months. Children as well as adults suitable for operation. Results in this series far better than previous experience with non-operative treatment.—*W. B. Carrell, M.D., Dallas, Texas.*

Symposium on the Sympathetic Nervous System. Certain Surgical Problems. Alexander Forbes and Stanley Cobb, Boston. Anatomy with Reference to Sympathectomy and Ramisection. S. W. Ranson, St. Louis. Effect on Spastic Paralysis. Loyal Davis and Allen B. Kanavel, Chicago. *Jour. Am. Med. Assoc.*, LXXXVI, 1884, June 19, 1926.

Ranson reviews the anatomy and physiology of the sympathetic system and it cannot be appreciated in abstract. As related to orthopaedic work, it is well to recall that a pair of ganglionated nerve cords or sympathetic trunks extend vertically through the neck, thorax and abdomen. Every spinal nerve is connected with the sympathetic trunk on its own side by gray rami which leave the ganglion of the sympathetic to join the nerve and be distributed to blood vessels, smooth muscle and questionably to striated muscle.

The thoracic and upper lumbar nerves are connected with the sympathetic through white rami. These white rami contain both afferent and efferent fibres and the latter convey impulses from the gray matter of the spinal cord to the sympathetic ganglion (preganglionic fibres) and end in synapse with gray rami or postganglionic fibres, thence to join spinal nerve, and carry efferent impulses. The lumbar sympathetic receives white rami from the upper thoracic, the last reaching it usually at the second lumbar ganglion. Vasoconstrictor impulses leave the spinal cord through the preganglionic fibres, cross to postganglionic fibres in the sympathetic trunk and, as gray rami, are distributed to peripheral blood vessels.

The hypothesis of Hunter and Royle that the unmyelinated fibres in striated muscle come from the sympathetic and control tonus not accepted. Observations of Hinsey (not published) cited to show that many fibres remained in muscle after complete degeneration of the sympathetic.

Experiments on cats convinced author that the sympathetic nervous system was not responsible for exaggerated tonus in decerebrate rigidity and from tetanus toxin.

Forbes and Cobb, discussing the tonus of striated muscle, reject the hypothesis of Langelaan that muscle has two separate mechanisms, namely, contractile and plastic tone. Such argument is based on misunderstanding of former observers and fails to harmonize with known physiology of nerve-muscle action.

When a nerve or muscle is stimulated, the response is of an all-or-none character. It cannot be varied by changing the stimulus provided it is sufficient to create any response. All of the known facts of plastic tone can be explained on this all-or-none response (unless it be proven that unmyelinated fibres ending in muscle are sympathetic and convey stimuli which influence some element of contraction).

Should efferent impulses pass from sympathetic to muscle end plates, then cutting rami should produce immediate effect and not the progressive change noted by Hunter and Royle.

Experiments were conducted on seventeen cats. Sympathectomy was done and after three to eight days the animals were decerebrated and a quantitative study made of the muscle tension. The results were not uniform. In some cases there was increased rigidity, in others, less, but no appreciable change on the two sides.

It is possible that chemical changes in the muscle following sympathectomy alters the resistance to fatigue and changes the tonus as observed in cases of Royle and others.

Davis and Kanavel recognize the dual innervation of striated muscle from the

cerebrospinal and sympathetic system, but do not accept the explanation of Hunter that muscle tone is controlled by the dual innerval and can be divided into component parts.

Experiments were carried out on eighteen cats. No change was noted in the operated, differing from the non-operated side of the decerebrate specimens.

Clinical cases have been studied up to eighteen months after operation and no change in reflexes, shortening and lengthening reactions were noted in any. Experimental and clinical results lead to rejection of Hunter and Royle's conclusions and suggest that other factors might affect muscle tone, as postoperative care, suggested chemical changes in muscles and hyperemia.

The consensus of opinion, as expressed by the several essayists, is that the sympathetic nervous system does not contribute any fibres of consequence to striated muscle and therefore has no relation to muscle tone. Results shown by Hunter, Royle and others must be explained on some other hypothesis.—*W. B. Carrell, M.D., Dallas, Texas.*

Fracture of the Anatomical Neck of the Humerus without Apparent Direct Violence. F. M. Blumer. *Lancet*, II, 22, July 3, 1926.

A farmer, aged 38, dislocated right shoulder six or seven years ago during an epileptic fit. After another attack recently a redislocation was diagnosed. Aware of the approach of the fit, the patient lay down on the floor, stretched his arms straight down by his side with the muscles tensely contracted. His wife heard a click. No blow was sustained at any time.

On manipulating the joint crepitus was felt. X-rays revealed fracture of the anatomical neck. A week later at operation, the fragment was removed. It was "loose within the capsule". There was no injury to the glenoid.—*Alexander Gibson, F.R.C.S., Winnipeg.*

Acute Pyogenic Infections of the Bones and Joints. E. D. Fenner. *New Orleans Med. and Surg. Jour.*, LXXIX, 83, August 1926.

The paper is very interesting and timely, as we all realize how many mistakes are made in the diagnosis of acute pyogenic bone infections. The author urges immediate operation as soon as the diagnosis is made, and advises the opening of the bone by means of a drill, trephine or chisel. Incision of the periosteum alone is not sufficient. Seven cases are reported. "The x-ray picture is utterly useless at the beginning, and should be regarded as a mere confirmation, if bone changes are seen, of a diagnosis which should have been made long before this."—*Edward S. Hatch, M.D., New Orleans, La.*

Arthroplasty. Ch. Lenormant. *Presse Méd.*, XXXIV, May 29, 1926.

An extensive consideration of the subject, presented at a session at the Val-de-Grâce. Briefly reviewed from the historical point. Murphy is credited with having originated the procedure, in 1902. It did not win favor to any extent in France until very recent years. The subject is discussed in regard to technique (operative and postoperative), indications and results. As to the latter, although the data are drawn from various nationalities, and are therefore representative enough, many of them are from reports of early date (1918 in the case of two large American groups), so that they cannot be said fairly to present the actual situation. Nevertheless they furnish very definite evidence of the great value of the operation, provided the generally recognized limitations as to indications are observed. The following quotation is of interest to those who are familiar with the results in this country: — "It is useless today to employ materials that have been already discarded or whose employment has not gained ground: such as chromicized pig-bladder, amniotic tissue, calves' arteries," etc. . . . "For an interposed tissue all surgeons today use aponeurotic or fat flaps; but two procedures persist: the pediculated and the free flap." Lenormant's choice is the free fascia flap. His postoperative treatment comprises two stages: (1) For ten to twenty days, immobilization, and, in joints that permit, continuous extension. (2) Mobilization, passive at first, then active and passive, together with all suitable mechano- and physiotherapeutic aids.—*Roades Fayerweather, M.D., Baltimore, Md.*

THE SURGICAL ASPECT OF BONE TUMORS. Henry W. Myerding, Rochester, Minn., *Radiology*, VII, 29, July 1926.

No operative procedure is justifiable, if malignancy is suspected, without roentgenological examination of the chest.

In operative removal of benign bone tumors, snug closure of the periosteum should be made, and precautions taken against hemorrhage within the periosteal sac, in order to avoid recurrence. In the treatment of chondromas, all of the tumor tissue must be removed, using cautery or chemicals if necessary, in order to assure non-recurrence.

In osteitis fibrosa cystica, curettage, crushing in of the exposed cortex, and layer suturing give the best results. Giant-cell tumors, considered benign, are treated by excision or curettage, with postoperative radiotherapy. Radiotherapy may supplant surgery in some cases. From clinical and radiographic examination alone these tumors may be mistaken for malignant sarcoma, tissue examination being the ultimate test.

Endothelioma or Ewing's tumor, formerly classed as round-cell sarcoma of bone, produces diffuse enlargement of the shaft, involving periosteum and periosseous structures, and causing moderate pain. The growth is slow, and radiographic findings diagnostic. Radiotherapy produces a temporary remission of size and of pain, but recurrence as metastases occurs after either surgery or radiation. These tumors respond more favorably to radiation than any other form of malignant bone tumor.

Surgery palliates but does not cure sarcomas, metastases in the lung always occurring after variable lengths of time. However, treatment may result in a period free from symptoms and lasting months or several years.—*Edward N. Reed, M.D., Ocean Park, Calif.*

A STUDY OF THE OSSIFICATION IN BONE SARCOMA. D. B. Phemister, Chicago. *Radiology*, VII, 17, July 1926.

Bone destruction and new bone formation can be studied in radiograms of bone sarcomas. The cytology of the tumor is an index of the palliative results to be expected from radiotherapy. In general, the less differentiated the tissue the greater the response to radiation; the more bone the tumor forms, the less responsive to radiation. New formed bone is tumorous or non-tumorous, the former arising from ossifying tumor cells, the latter from normal osteoblasts. The entire tumor may become converted into bone; or it may form no bone. The new bone may be spongy, or may be laid down in rays. In microscopic appearance it varies from extremely immature to nearly normal bone.

Non-tumorous new bone may arise from periosteum or endosteum and is more abundant in tumors of childhood and adolescence. It forms because of the stimulation of the tumor or to compensate for bone destruction.

Bone sarcomas may contain (1) tumor bone only, (2) both tumorous and non-tumorous bone, (3) non-tumorous bone only, (4) no new bone. Those of the first type occur usually in adults, and are osteogenic sarcomas or chondrosarcomas, the latter being much the rarer variety. In radiograms isolated calcareous shadows within a tumor are almost pathognomonic of chondrosarcoma. Tumors of types 2 and 3 are seen mainly in adolescents; those of type 4 commonly occur in adults.

The article contains radiograms of the various types, description of their characteristics, and case histories.—*Edward N. Reed, M.D., Ocean Park, Calif.*

RADIATION IN THE TREATMENT OF BONE TUMORS. Albert Soiland and William E. Costolow, Los Angeles. *Radiology*, VII, 36, July 1926.

Simple bone tumors, exostoses, certain types of bone cysts and chondromas are considered surgical problems; inflammatory tumors, sarcomas and carcinomas are considered preferably radiological problems. Four cases with apparent cure by radiation are reported. An adamantinoma of the lower jaw, duration more than twenty years, treated by buried radium needles and deep x-ray, is apparently arrested two years after the last treatment, although some enlargement of the bone containing a

cystic area still remains. There are reported also two cases of marked palliation from the treatment of metastatic carcinomas. One of these was kept comfortable until the time of her death; the second, still living, has been free from pain for two years, has gained considerable weight, and at present is apparently enjoying good health in every way.—*Edward N. Reed, M.D., Ocean Park, Calif.*

Patella Bipartita. Marcel L'Heureux and Adrien Riche. *Revue D'Orthopedie*, XIII, No. 1, 34, January 1926.

Ossification of the patella begins at the age of two years by one point and the process ends at twenty-five years. Portal and Rudolph state that there are two or three more points, but all of them become fused at the above age. When they develop independently the anomaly known as patella bipartita, or tripartita, results. This name was given by Wenzel Grüber who saw it in a skeleton of a man about twenty-one years of age.

In boys, from ten to fourteen years, complaining of pain in the knees following a trauma, with or without hydrarthrosis or infiltration of tissues, the x-ray has shown this peculiarity, involving both bones.

The nature of this affection probably belongs to the same obscure pathology as the so-called apophysites of growth.

The patella bipartita ought to be differentiated from a comminuted fracture, osteoma of the quadriceps ligaments and from a rarer anomaly, supernumerary patella discovered by Retter and Vallas in the crural tendon.—*Felipe Muro, M.D., Detroit, Mich.*

On Amputations: Eugen Sattler. *Ztschr. f. orthop. Chir.*, XLVII, 2, 268, February 15, 1926.

Amputations on the upper extremity are discussed very briefly. Conservatism is emphasized, especially in the treatment dealing with the fingers.

Of the operations on the foot, Chopart's gives good results while the method of Lisfranc often is complicated by ulcerations and other circulatory disturbances of the stump. Chopart's amputation furnishes a stump of good weight-bearing qualities. The equinus position which occasionally occurs can be corrected by tenotomy of the tendo Achillis. In order to secure a good end-result it is important that active mobility, especially that of the dorsi-flexors, be preserved and that the suture line of the flap be entirely on the dorsum of the foot.

If Chopart's amputation cannot be done, the next operation chosen by most surgeons is that of Pirogoff, a method which can be relied upon to yield a good weight-bearing stump. It is important that the bony surfaces fit clearly and without strain and that the region of the tendo Achillis is not infiltrated or shows scar formation. The end of the stump is to be formed by the skin of the under side of the heel and not by that over the insertion of the tendo Achillis. If the proper soft part covering cannot be obtained at this level, a modification of Sedillot or the operation of Syne is recommended—the latter is easy and gives a very good weight-bearing stump.

For the next level the author recommends the amputation at the border between middle and upper thirds of the tibia—long stumps in the lower third are not so good in weight-bearing and often show cyanosis and oedema. The amputation in the upper third of the leg gives good results provided that the stump has a minimum length of ten to twelve centimeters. If shorter than six centimeters it is unsuitable for a prosthesis and in this case the osteoplastic intra-condylar amputation of Ssabanjeff or better the amputation of Gritti is to be preferred.

Amputation on the thigh may be carried out successfully in the lower as well as in the middle third. Here again if the stump is too short it gives rise to hip contracture which greatly complicates the use of prosthesis. In the opinion of the author the exarticulation of the hip joint should be carried out in extreme cases only.

Regarding the after-treatment the author is of the opinion that the correction of

the contractures either before or immediately after amputation is of the greatest importance, especially since it is difficult to retain the patient in the hospital for prolonged after-treatment after amputation.

In selecting the type of artificial limb the occupation of the patient is to be taken into consideration and the simpler the prosthesis the better.

Eleven thousand cases of amputation are being cared for in Hungary and in each amputation of the leg a working prosthesis is issued as well as a cosmetic one. Likewise in upper extremity operations a working arm is furnished as well as a cosmetic arm with a cosmetic hand.

An artificial leg is exchanged every two years for men who do heavy manual labor and for those doing lighter work, every four years. The artificial arm can be exchanged every four years.

It has been the experience of the author, like that of many others, that only a small portion of the cases of arm amputations use the artificial while the rest try to get along with the stump.—*A. Steindler, Iowa City, Iowa.*

ADOLESCENT SPINAL CURVATURE. J. Kochs. *Zeitsch f. Orthopaed. und Unfallchir,* XXIV, 1, January 1926.

It is an established clinical fact that during the adolescence there originate in the spine various curvatures which may have pre-existed and remained overlooked, or may have become aggravated during this period. Etiologically three periods come under consideration: (1) During puberty the resisting power of the body is greatly reduced in view of inner secretory disturbances, (2) When young persons overtax their physical ability, especially is the spine overburdened, the consequence of which is a predominence of the functional demand over the functional capacity of the spine, and (3) The circumstances of growth of the spinal bodies undoubtedly play a part in the formation of these deformities. This point has been emphasized recently by many writers. Radiographic studies have taught that during adolescence there appear on the corners, viewed laterally, of the spinal bodies, triangular, narrow, drawn out shadows which are nothing but normal deposits of calcium in the hyaline cartilages of the intervertebral discs. From these epiphyseal discs the formation of the bodies takes place,—the previous biconvex forms change into the normal biconcave, in virtue of endochrondral growth and gradual ossification of the discs. The time period of this normal principle of growth is variable and extends between the ages of ten to twenty. About the age of twenty, the ossification of the bodies is usually complete. The beginning as well as the completion of this process is earlier in girls than in boys. In the areas of these epiphyses there frequently occur disturbances during adolescence. These changes are characterized in the x-ray as follows: the contour of the triangular discs are irregular, fragmented and but faintly noticeable; frequently it appears sunken at the front part of the bodies of the vertebrae. The bodies themselves are moth-eaten, beaker-shaped, and irregular in outline. In highly developed cases, the picture resembles tuberculous caries. The epiphyseal space is mostly widened. A few cases have been periodically x-rayed and have demonstrated a certain amount of restitution and restoration of the shape of the vertebral bodies, a disappearance of the rarification and, in cases of long standing, the appearance of spur-like hypertrophic areas. Such cases resemble the spondylitis deformans. The changes which occur in these adolescent spines resemble the disturbances of growth about the hips, the heels, the tibial tubercles and other regions. They also appear similar to the so-called late rachitic conditions. The clinical pictures are well enough known and need no further mention. The prognosis is not favorable as to self-correction of the deformity or of correction by therapy. Even the cases where there has been immobilization of the spine by the application of a jacket, the wearing of a brace, or by recumbency and heliotherapy, the correction could not be overcome, although improvement has been noticeable.—*A. Gottlieb, M.D., Los Angeles, Calif.*

INDEX TO VOLUME VIII

1926

OLD SERIES VOLUME XXIV

AUTHORS

A

PAGE

Adams, Z. B. Two Unusual Conditions Presenting an Obstacle to the Reduction Found by Open Operation for Congenital Dislocation of the Hip 507
Albee, Fred H. Mechanical Employment of Sequestrum Fracture of Femur 325
Allison, Nathaniel. Comparative Studies Between Synovial Fluid and Plasma .. 758
Ashcroft, G. V. Renal Rickets 279

B

Baer, W. S. Arthroplasty of the Hip 769
Baldwin, C. H. Congenital Dislocation of the Knee Joint 822
Balensweig, Irvin. Congenital Dislocation of the Hip: Replacement Operation .. 534
Bennett, George E. Congenital Malposition of the Left Fibula 405
Berry, John M. A Theory as to the Cause of Perthes' Disease Based on Roentgenologic Findings 333
Bloodgood, Joseph C. How to Diagnose and Treat a Bone Lesion. I. Central Lesions 470
Bone Sarcoma—Periosteal and Diffuse Type, and their Diagnosis from Benign Lesions 727
Burbank, Reginald. Vaccine Therapy and Serological Diagnosis in the Arthritides 657

C

Campbell, Willis C. An Apparatus for the Correction of Flexion Contracture of the Knee 416
Christopher, Frederick. Painful Exostosis of Little Toe: An Operation for its Relief 821
Clark, William Arthur. Fractures of the Femur in Children 273
A Light Portable Extension Frame 750
Conwell, H. Earle. Fractures of the Surgical Neck and Epiphyseal Separations of the Upper End of the Humerus 508
Cotton, F. J. Disinfection of Septic Joints 395

D

Dailey, Mary Elizabeth. Comparative Studies between Synovial Fluid and Plasma 758
Dresel, R. L. St. Luke's Fracture Bed 427

E

Edwards, Harold C. The Mechanism and Treatment of Backfire Fracture 701
Elliott, George R. A Contribution to Spinal Osteo-arthritis Involving the Cervical Region 42

F

Farrell, Benjamin P. Congenital Dislocation of the Hip: A Report of Three Hundred and Ten Cases Treated at the New York Orthopaedic Dispensary and Hospital 551
Flagstad, Albert E. Traction Apparatus Used in Correcting Equinus Deformities 718
Forbes, A. MacKenzie. The Infective Arthritides 374
The Tensor Fasciae Femoris 589
Freiberg, Albert H. The So-called Infraction of the Second Metatarsal Bone 257
Fremont-Smith, Frank. Comparative Studies between Synovial Fluid and Plasma 758

G

Galloway, Herbert P. H. The Open Operation for Congenital Dislocation of the Hip: Special Reference to Results 539

PAGE

Garr, Charles C. Spontaneous Fracture Following Bone Banding for Fractures 377
Geist, Emil S. Anterior Tarsectomy (Ollier) in Tuberculosis of the Anterior Tarsus 410
Ghormley, Ralph K. Joint Disease 858

H

Hammond, Roland. Transplantation of the Fibula to Replace Bony Defect in the Shoulder Joint 627
Harbin, Maxwell. Non-suppurative Osteomyelitis, with Report of an Unusual Case 401
Harding, Maynard C. Os Calcis Fractures: A New Method of Reduction 720
Henderson, Melvin S. Chronic Ostitis of the Semilunar Bone. (Kienböch's Disease) 504
Ununited Fractures with Special Reference to the Chemistry of the Blood 607
Hibbs, Russell A. A Preliminary Report of Twenty Cases of the Hip Joint Tuberculosis. Treated by an Operation Devised to Eliminate Motion by Fusing the Joint 522
Hoke, Michael. President's Address 467

J

Jansen, Murk. March Foot 262
Jones, Sir Robert. Some Remarks on the Training and Activities of the Orthopaedic Surgeon 247

K

Kennard, Margaret A. Comparative Studies between Synovial Fluid and Plasma 758
Key, J. Albert. Epiphyseal Coxa Vara or Displacement of the Capital Epiphysis of the Femur in Adolescence 53
The Mechanisms Involved in the Removal of Colloidal and Particulate Carbon from Joint Cavities 666
Kidner, Frederick C. An Unusual Case of Legg Perthes' Disease 565

L

Lasher, Willis W. Introductory Considerations in the Study of Cartilage Injuries 651
LeMesurier, A. B. Artificial Limbs: Their Relation to the Different Types of Amputation Stumps 292
Lewin, Philip. A Simple Removable Head Suspension Sling 422
Magnuson, Paul B. Protein Arthritis 839
Mayer, Leo. Tendon Transplantations for Division of the Extensor Tendon of the Fingers 383

M

Milch, Henry. Avulsion Fracture of the Tuberosity of the Ischium 832
Mitchner, James M. An Apparatus for the Correction of Flexion Contracture of the Knee 416
Mumford, E. B. Trophic Osteopathy 601

N

Noble, Thomas P. Ununited Fractures with Special Reference to the Chemistry of the Blood 607

O

Osgood, Robert B. Orthopaedic Aspects of Chronic Arthritis 1

P

Painter, Charles F. The Classification of Arthritis 354
Peterson, Carl A. The Danger in the Use of Lipiodol in the Diagnosis of Obstructive Lesions of the Spinal Canal 348
Philips, Herman B. Paget's Disease 643
Porter, John L. A Traction Loop for the Foot 414
Traction in Diseases and Deformities of the Joints 753

R

Rogers, William A. End-result Study of Arthrodesis of the Sacro-iliac Joint for Arthritis—Traumatic and Non-traumatic 118
Rollier, A. Pott's Disease 360
Ryerson, Edwin W. Congenital Dislocation of the Hip. Celluloid Casts for Infants 517

S

PAGE

Sandiford, Kathleen. Ununited Fractures with Special Reference to the Chemistry of the Blood ... 607
Schauffler, Robert McE. Transplant of the Upper Extremity of the Fibula to Replace the Upper Extremity of the Humerus ... 723
Schlueter, S. A. Avulsion of the Lesser Trochanter ... 766
Schrock, Robert D. Congenital Elevation of the Scapula ... 207
Shands, A. R., Jr. An Analysis of One Hundred X-rays of Patellae in Children between the Ages of Two and One-half and Six Years, with Especial Reference to the Center of Ossification and a Report of One Case of Delayed Ossification of the Patellae ... 824
Sharpe, William. The Danger in the Use of Lipiodol in the Diagnosis of Obstructive Lesions of the Spinal Canal ... 348
Sherman, Wm. O'Neill. The Operative Treatment of Fractures of the Shaft of the Femur with Maximum Fixation ... 494
Silver, David. The Operative Treatment of Congenital Torticollis. Advantages of Exsection of the Two Heads of the Sternocleidomastoid ... 489
Smith, Alan DeF. Congenital Dislocation of the Hip. A Report of Three Hundred and Ten Cases Treated at the New York Orthopaedic Dispensary and Hospital 551
Smith, Lemuel D. Tuberculosis of the Hip in Children ... 636
Smith-Petersen, M. N. End-result Study of Arthrodesis of the Sacro-iliac Joint for Arthritis—Traumatic and Non-traumatic ... 118
Steindler, Arthur. Compensation vs. Correction in the Treatment of Structural Scoliosis ... 570
Steinfeld, Alexander M. Spontaneous Reduction of a Right Hip Joint in a Bilateral Case of Congenital Dislocation of the Hip ... 519
Swaim, Loring T. The Orthopaedic Principles in the Treatment of Chronic Arthritis ... 845

T

Telson, David R. A Clubfoot Wrench ... 425

V

Van Dessel, Arthur. Behaviour of Sequestra in Chronic Osteomyelitis ... 194
Verrall, P. Jenner. A Bone Graft for Sacro-iliac Fixation ... 491
Von Lackum, Herman L. Operations in the Treatment of Spastic Paralysis ... 590
Congenital Dislocation of the Hip: A Report of Three Hundred and Ten Cases Treated at the New York Orthopaedic Dispensary and Hospital ... 551

W

Weinberg, Edwin. Osteomata of Lower End of Tibia ... 562
Wentworth, Edward T. Systematic Diagnosis in Backache ... 137
Whitman, Armitage. Remarks Prefatory to a Cinematographic Presentation of Late Results of the Reconstruction Operation ... 803

Y

Yergason, R. M. Apparatus for Postoperative Management of Guillotine Amputation of the Thigh ... 216
Yount, C. C. The Rôle of the Tensor Fasciae Femoris in Certain Deformities of the Lower Extremities ... 171

Z

Zadek, Isadore. The Significance of the Accessory Tarsal Scaphoid ... 618

TITLES OF ARTICLES

PAGE

Apparatus for the Correction of Flexion Contracture of the Knee. Willis C. Campbell, James W. Mitchner ... 416
Apparatus for Postoperative Management of Guillotine Amputations of the Thigh. R. M. Yergason ... 216
Apparatus
Artificial Limbs: Their Relation to the Different Types of Amputation Stumps. A. B. LeMesurier ... 292
Celluloid Casts for Infants—Congenital Dislocation of the Hip. Edwin W. Ryerson ... 517
Clubfoot Wrench, A. David R. Telson ... 425
Fracture Bed, St. Luke's. R. L. Dresel ... 427
Light Portable Extension Frame, A. William Arthur Clark ... 750
Simple Removable Head Suspension Sling, A. Philip Lewin ... 422
Traction Apparatus Used in Correcting Equinus Deformities. Albert E. Flagstad ... 718
Traction in Diseases and Deformities of the Joints. John L. Porter ... 753
Traction Loop for the Foot, A. John L. Porter ... 414
Arthritides, The Infective. A. Mackenzie Forbes ... 374
Arthritides, Vaccine Therapy and Serological Diagnosis in the. Reginald Burbank 657
Arthritis, Chronic, The Orthopaedic Aspects of. Robert B. Osgood ... 1
Arthritis, Chronic, The Orthopaedic Principles in the Treatment of. Loring T. Swaim ... 845
Arthritis, The Classification of. Charles F. Painter ... 354
Arthritis, Protein. Paul B. Magnuson ... 839
Arthritis, Traumatic and Non-traumatic, End-result Study of Arthrodesis of the Sacro-iliac Joint for. M. N. Smith-Petersen, William A. Rogers ... 118
Arthroplasty of the Hip. W. S. Baer ... 769
Artificial Limbs: Their Relation to the Different Types of Amputation Stumps. A. B. LeMesurier ... 292

Backache, Systematic Diagnosis in. Edward T. Wentworth ... 137
Bradford, Edward Hickling. Obituary ... 460

Cartilage Injuries, Introductory Considerations in the Study of. Willis W. Lasher 651
Clinical Conferences ... 222, 432, 688, 890
Clubfoot Wrench, A. David R. Telson ... 425
Congenital Dislocation of the Hip. Celluloid Casts for Infants. Edwin W. Ryerson ... 517
Congenital Dislocation of the Hip. The Open Operation for: Special Reference to Results. Herbert P. H. Galloway ... 539
Congenital Dislocation of the Hip: Replacement Operation. Irvin Balensweig ... 534
Congenital Dislocation of the Hip: A Report of Three Hundred and Ten Cases Treated at the New York Orthopaedic Dispensary and Hospital. Benjamin P. Farrell, Alan DeF. Smith, Herman L. Von Lackum ... 551
Congenital Dislocation of the Hip, Spontaneous Reduction of a Right Hip Joint in a Bilateral Case of. Alexander M. Steinfeld ... 519
Congenital Dislocation of the Hip, Two Unusual Conditions Presenting an Obstacle to the Reduction found by Open Operation for. Z. B. Adams ... 507
Congenital Dislocation of the Knee Joint. C. H. Baldwin ... 822
Congenital Elevation of the Scapula. Robert D. Schrock ... 207
Congenital Malposition of the Left Fibula. George E. Bennett ... 405
Congenital Torticollis, The Operative Treatment of, Advantages of Exsection of the Two Heads of the Sternocleidomastoid. David Silver ... 489
Coxa Vara, Epiphyseal, or Displacement of the Capital Epiphysis of the Femur in Adolescence. J. Albert Key ... 53
Current Literature ... 230, 441, 696, 893

Exostosis, Painful, of Little Toe: An Operation for its Relief. Frederick Christopher ... 821

Fassatt, Fred. J. Obituary ... 466
Fracture of the Tuberosity of the Ischium, Avulsion. Henry Milch ... 832
Fracture, Backfire, The Mechanism and Treatment of. Harold C. Edwards ... 701

PAGE

Fracture Bed, St. Luke's. R. L. Dresel ... 427
Fractures of the Femur in Children. William Arthur Clark ... 273
Fractures of the Shaft of the Femur with Maximum Fixation, The Operative Treatment of. Wm. O'Neill Sherman ... 494
Fractures, Os Calcis, A New Method of Reduction. Maynard C. Harding ... 720
Fracture of Femur, Mechanical Employment of Sequestrum. Fred H. Albee ... 325
Fracture, Spontaneous, Following Bone Banding for Fractures. Charles C. Garr ... 377
Fractures of the Surgical Neck and Epiphyseal Separations of the Upper End of Humerus. H. Earle Conwell ... 508
Fractures, Ununited, With Special Reference to the Chemistry of the Blood. Melvin S. Henderson, Thomas P. Noble, Kathleen Sandiford ... 607
Frame, A Light Portable Extension. William Arthur Clark ... 750

Head, Removable, A Simple, Suspension Sling. Philip Lewin ... 422
Hip, Arthroplasty of the. W. S. Baer ... 769
Hip: Remarks Prefatory to a Cinematographic Presentation of Late Results of the Reconstruction Operation. Armitage Whitman ... 803
Humerus. Transplant of the Upper Extremity of the Fibular to Replace the Upper Extremity of the. Robert McE. Schauffler ... 723

Infraction of the Second Metatarsal Bone, The So-called. Albert H. Freiberg ... 257

Joint Cavities, The Mechanism Involved in the Removal of Colloidal and Particulate Carbon from. J. Albert Key ... 666
Joint Disease. Ralph K. Ghormley ... 858

Kienböch's Disease: Chronic Osteitis of the Semilunar Bone. Melvin S. Henderson ... 504
Knee, An Apparatus for the Correction of Flexion Contracture of the. Willis C. Campbell, James M. Mitchner ... 416

Legg-Perthes' Disease, An Unusual Case of. Frederick C. Kidner ... 565
Lesion, Bone, How to Diagnose and Treat a, I. Central Lesions. Joseph C. Bloodgood ... 470
Lesions, Bone Sarcoma, Periosteal and Diffuse Type, and Their Diagnosis from Benign. Joseph C. Bloodgood ... 727
Lesions of the Spinal Canal, The Danger in the Use of Lipiodol in the Diagnosis of Obstructive. William Sharpe, Carl A. Peterson ... 348

March Foot. Murk Jansen ... 262
Metatarsal Bone, The So-called Infraction of the Second. Albert H. Freiberg ... 257
Myers, T. Halstead. Obituary ... 466

News Notes ... 226, 437, 684, 884

Orthopaedic Surgeon, Some Remarks on the Training and Activities of the. Sir Robert Jones ... 247
Osteitis, Chronic, of the Semilunar Bone, (Kienböch's Disease). Melvin S. Henderson ... 504
Osteo-arthritis, Spinal, Involving the Cervical Region, A Contribution to. George R. Elliott ... 42
Osteomata of Lower End of Tibia. Edwin Weinberg ... 562
Osteomyelitis, Chronic, Behaviour of Sequestra in. Arthur Van Dessel ... 194
Osteomyelitis, Non-suppurative, with Report of an Unusual Case. Maxwell Harbin ... 401

Paget's Disease. Herman B. Philips ... 643
Paralysis, Spastic, Operations in the Treatment of. Herman L. Von Lackum ... 590
Patellae, An Analysis of One Hundred X-rays of, in Children between the Ages of Two and One-Half and Six Years, with Especial Reference to the Center of Ossification and a Report of One Case of Delayed Ossification of the Patellae. A. R. Shands, Jr. ... 824
Perthes' Disease, A Theory as to the Cause of, Based on Roentgenologic Findings. John M. Berry ... 333
Pott's Disease. A. Rollier ... 360
President's Address. Michael Hoke ... 467

PAGE

Reconstruction Operation, Remarks Prefatory to a Cinematographic Presentation of Late Results of the. Armitage Whitman 803
Rickets, Renal. G. V. Ashcroft 279

Sacro-iliac Fixation, A Bone Graft for. P. Jenner Verrall 491
Sacro-iliac Joint, End-result Study of Arthrodesis of, for Arthritis—Traumatic and Non-traumatic. M. N. Smith-Petersen, William A. Rogers 118
Scaphoid, Tarsal, The Significance of the Accessory. Isadore Zadek 618
Scoliosis, Structural, Compensation vs. Correction in the Treatment of. Arthur Steindler 570
Septic Joints, Disinfection of. F. J. Cotton 395
Shoulder Joint, Transplantation of the Fibula to Replace Bony Defect in the. Roland Hammond 627
Spinal Canal, The Danger in the Use of Lipiodol in the Diagnosis of Obstructive Lesions of the. William Sharpe, Carl A. Peterson 348
Synovial Fluid and Plasma, Comparative Studies between. Nathaniel Allison, Frank Fremont-Smith, Mary Elizabeth Dailey, Margaret A. Kennard 758

Tendon Transplantations for Division of the Extensor Tendon of the Fingers. Leo Mayer 383
Tensor Fasciae Femoris, The. A. Mackenzie Forbes 589
Tensor Fasciae Femoris, The Rôle of the, in Certain Deformities of the Lower Extremities. C. C. Yount 171
Thigh, Apparatus for Postoperative Management of Guillotine Amputations of the. R. M. Yergason 216
Tibia, Osteomata of Lower End of. Edwin Weinberg 562
Traction Apparatus Used in Correcting Equinus Deformities. Albert E. Flagstad 718
Traction in Diseases and Deformities of the Joints. John L. Porter 753
Traction Loop for the Foot, A. John L. Porter 414
Transplant of the Upper Extremity of the Fibula to Replace the Upper Extremity of the Humerus. Robert McE. Schauffler 723
Transplantation of the Fibula to Replace Bony Defect in the Shoulder Joint. Roland Hammond 627
Transplantations, Tendon, for Division of the Extensor Tendon of the Fingers. Leo Mayer 383
Trochanter, Avulsion of the Lesser. S. A. Schlueter 766
Trophic Osteopathy. E. B. Mumford 601
Tuberculosis of the Anterior Tarsus, Anterior Tarsectomy (Ollier) in. Emil S. Geist 410
Tuberculosis of the Hip in Children. Lemuel D. Smith 636
Tuberculosis, Hip Joint, A Preliminary Report of Twenty Cases of, Treated by an Operation Devised to Eliminate Motion by Fusing the Joint. Russell A. Hibbs 522

Vaccine Therapy and Serological Diagnosis in the Arthritides. Reginald Burbank 657

The Journal of Bone and Joint Surgery

THE OFFICIAL PUBLICATION OF THE
AMERICAN ORTHOPAEDIC ASSOCIATION
and of the
BRITISH ORTHOPAEDIC ASSOCIATION

Issued Quarterly

For the British Orthopaedic Association

Editorial Secretary
H. PLATT, M.S., F.R.C.S.

Editorial Committee
A. S. B. BANKART, M.C., F.R.C.S.
E. W. HEY GROVES, M.S., F.R.C.S.
W. A. COCHRANE, M.B., F.R.C.S. (Ed.)

For the American Orthopaedic Association

Editor
E. G. BRACKETT, M.D.

Editorial Committee
J. L. PORTER, M.D.
DE FOREST P. WILLARD, M.D.
A. MACKENZIE FORBES, M.D.

Advisory Editorial Staff

SAMUEL C. BALDWIN, M.D.
EDWARD C. BULL, M.D.
C. N. CALLENDAR, M.D.
W. B. CARRELL, M.D.
F. B. COFIELD, M.D.
WALLACE H. COLE, M.D.
H. EARLE CONWELL, M.D.
CHARLES F. EIKENBARY, M.D.
C. B. FRANCISCO, M.D.
FRED. J. GAENSLEN, M.D.
R. I. HARRIS, M.D.
EDWARD S. HATCH, M.D.
MURK JANSEN, M.D.
FREDERICK A. JOSTES, M.D.
FREDERICK C. KIDNER, M.D.
PHILIP LEWIN, M.D.
ANDREW P. MacKINNON, M.D.
EARL D. McBRIDE, M.D.
HENRY P. MAUCK, M.D.
OSCAR LEE MILLER, M.D.
I. WILLIAM NACHLAS, M.D.
H. WINNETT ORR, M.D.
WILLIAM B. OWEN, M.D.
EDWARD A. RICH, M.D.
ROBERT SCHROCK, M.D.
JAMES S. SPEED, M.D.
ARTHUR STEINDLER, M.D.
JOHN C. WILSON, M.D.
JAMES WYANT, M.D.
F. P. YORSTEN, M.D.
CARL C. YOUNT, M.D.

VOL. VIII. No. 4 OCTOBER, 1926 Old Series Vol. XXIV. No. 4

166 NEWBURY STREET, BOSTON, MASSACHUSETTS, U. S. A.

Athenia Corsets

for

Spinal and Abdominal Support

MADE on natural lines to fit the average normal figure. Designed with the help and advice of eminent physicians to give support to the natural curve of the spine and abdomen without pressure at the waist or diaphragm.

As no corset will fit every figure, adjustments and alterations are often necessary and should be made under our supervision. For cases where this is impossible, we have prepared careful directions to insure proper fitting.

CORA CHANDLER
"CHANDLER'S CORSET STORE"
50 ··TEMPLE PLACE··50
BOSTON

Telephone Beach 5134 Established 1897 Cable Address "Corset"

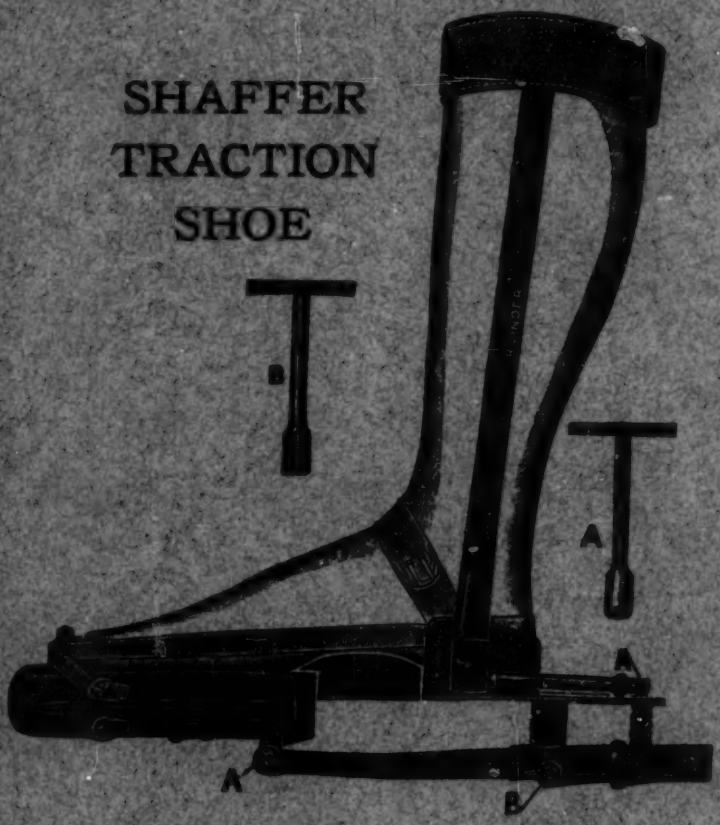
ROBERT LINDER, Inc.

Manufacturers of
Perfect Mechanically Constructed

Orthopaedic Appliances

For Over Half a Century

SHAFFER
TRACTION
SHOE



No. 148 East 53rd Street, New York

Tel. Plaza 7206 Established 1863

PRINTED IN U. S. A. BY T. O. METCALF COMPANY, BOSTON, MASS.